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Hours, Fatigue, and Health in British Munition
Factories. 1917

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PUBLICATIONS OF THE BUREAU OF LABOR STATISTICS.

[The publication of the annual and special reports and of the bimonthly bulletin has been discontinued, and since July, 1912, a bulletin has been published at irregular intervals. Each number contains matter devoted to one of a series of general subjects. These bulletins are numbered consecutively in each series and also carry a consecutive whole number, beginning with No. 1st. A complete list of the reports and bulletins of the Bureau will be furnished on application.]

A list of the series of bulletins now published by the Bureau is as follows:

- Wholesale Prices.
- Retail Prices and Cost of Living.
- Wages and Hours of Labor.
- Employment and Unemployment.
- Women in Industry.
- Workmen's Insurance and Compensation (including laws relating thereto).
- Industrial Accidents and Hygiene.
- Constitution and Arbitration (including strikes and lockouts).
- Labor Laws of the United States (including decisions of courts relating to labor).
- Foreign Labor Laws.
- Vocational Education.
- Miscellaneous Series.

INDUSTRIAL ACCIDENTS AND HYGIENE.

Prior to the publication of the bulletin of the Bureau in the present form, many reports are issued devoted wholly or in part to the subject of "Industrial Accidents and Hygiene." For a full list of these, the reader is referred to Bulletin No. 174, Subject Index to the Publications of the Bureau of Labor Statistics, up to May 1, 1915. Reports dealing with the subjects are follows:

- Bul. 49, May, 1900, Report of French Bureau of Labor regarding industrial hygiene.
- Bul. 41, January, 1903, Factory sanitation and labor protection.
- Bul. 55, November, 1904, Acetate lead and zinc works, 1904.
- Bul. 72, September, 1907, Health of Cornish miners, 1907.
- Bul. 75, March, 1908, Industrial hygiene.
- Bul. 77, July, 1908, Compensation for industrial diseases, Great Britain, 1906.
- Bul. 78, September, 1908, Mortality from consumption in Dutch trade.
- Bul. 80, January, 1909, Compensation for industrial diseases, Great Britain, 1906.
- Bul. 82, May, 1909, Mortality from consumption in occupations exposed to smouldering and gaseous impurities.
- Twenty-fourth Annual Report, 1909, Workmen's Insurance and compensation systems in Europe.
- Bul. 86, January, 1910, Phosphorus poisoning in the match industry in the United States.
- Tentative list of industrial poisons.
- Bul. 88, July, 1910, Child labor legislation in Europe.
- Bul. 89, January, 1911, Resolutions of International Association for Labor Legislation, Industrial Hygiene.
- Report of Illinois commission on occupational diseases.
- Bul. 90, July, 1911, Industrial lead poisoning in Great Britain and Western Europe.
- The white-lead industry in the United States, with an appendix on the lead-white industry.
- Deaths from industrial lead poisoning in New York State in 1909 and 1910.
- Laws enacted during 1911, regarding the report of occupational diseases.
- Bul. 92, September, 1911, Attitude of Massachusetts employers toward the health of their employees.
- 1911, Conditions of employment in the iron and steel industry in the United States (3d Dec. 1910 Conference, London), Vol. III.
- 1912-1913, Report on condition of women and child wage earners in the United States (3d Dec. 1910 Conference, London), Vol. I.
- Vol. I. Cotton textile industry.
- Vol. II. Men's ready-made clothing.
- Vol. III. Glass industry.
- Vol. IV. Silk industry.
- Vol. XI. Employment of women in the metal trades.
- Vol. XII. Employment of women in textiles.
- Vol. XIV. Causes of death among women and child cotton-textile operators.
- Vol. XV. Health from disease and infection—mill operatives.
- Vol. XVI. Employment of women and children in selected industries.
- Vol. XVII. Labor law and factory conditions.
- Bul. 93, January, 1912, Constitution, arbitration, and mediation in the steel, rail, and shipbuilding in New York City.
- Bul. 99, May, 1912, List of industrial poisons.

* Supply exhausted.

[See also third page of cover]

U. S. DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS

ROYAL WEBBER, Commissioner

BULLETIN OF THE UNITED STATES) . . . (WHOLE 221
BUREAU OF LABOR STATISTICS) . . . (NUMBER 221)

INDUSTRIAL ACCIDENTS AND HYGIENE SERIES - No. 18

HOURS, FATIGUE, AND HEALTH
IN BRITISH MUNITION FACTORIES

REPRINTS OF THE MEMORANDA
OF THE BRITISH HEALTH OF
MUNITION WORKERS COMMITTEE



APRIL, 1917

WASHINGTON
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Dr Benjamin Rand

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PREFACE.

This bulletin is the first of a group of bulletins to be published by the Bureau of Labor Statistics of the United States Department of Labor, in compliance with the following resolution voted April 7, 1917, by the Council of National Defense:

That the complete reports of the committee appointed by the British Minister of Munitions to investigate conditions affecting the health and welfare of workers be edited so that the salient features thereof may be made applicable to the conditions pertaining in the United States and printed in condensed form by the Department of Labor.

The matter contained in the reports and memoranda issued by the British Health of Munition Workers Committee is of such interest and importance that the documents relating to hours, fatigue, and occupational diseases are reproduced in full in this bulletin.

Later bulletins will contain documents, official and nonofficial, dealing with welfare work and the employment of women and juveniles and such related documents, either official or nonofficial, as are of sufficient interest and importance to warrant reprinting or summarizing in bulletin form.

It is thought that these bulletins, published at the request of the Council of National Defense, will be of great service to the country by giving wider circulation to the experiences of Great Britain, France, Canada, and other countries in dealing with labor in the production of the largest quantity of munitions in the shortest space of time.

ROYAL MEEKER,
United States Commissioner of Labor Statistics.

BULLETIN OF THE U. S. BUREAU OF LABOR STATISTICS.

WHOLE NO. 221.

WASHINGTON.

APRIL, 1917

HOURS, FATIGUE, AND HEALTH IN BRITISH MUNITION FACTORIES.

INTRODUCTION.

The British Health of Munition Workers Committee was appointed in the middle of September, 1915, by the Minister of Munitions, with the concurrence of the Home Secretary, "to consider and advise on questions of industrial fatigue, hours of labor, and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops."

The composition of the committee is as follows:

Sir George Newman, M. D. (chairman).

Sir Thomas Barlow, Bart., K. C. V. O., M. D., F. R. S.

G. Bellhouse, factory department, Home Office.

Prof. A. E. Boycott, M. D., F. R. S.

J. R. Clynes, M. P.

E. L. Collis, M. B., factory department, Home Office.

W. M. Fletcher, M. D., F. R. S., Secretary of Medical Research Committee.

Leonard E. Hill, M. B., F. R. S.

Samuel Osborn, J. P., Sheffield.

Miss R. E. Squire, factory department, Home Office.

Mrs. H. J. Tennant.

E. H. Pelham (secretary).

The committee took evidence in various industrial centers from employers, representatives of workers, and other interested persons, and made numerous special studies and investigations. In addition, members visited a large number of factories and workshops, and discussed matters with the management, with foremen, and with individual workers. With this information, and having the advantage of the special knowledge and experience already possessed by members of the committee, it has published up to the present time (April, 1917) 15 memoranda, dealing with one or more of the subjects intrusted to it.

As these memoranda are the work of a committee especially qualified by technical knowledge and special experience, and present many suggestions and recommendations made with the purpose of

securing maximum output over a period of months, or even years, and at the same time safeguarding the health and physical efficiency of the workers, it is believed that their reproduction at this time will be of value in a similar way to industry and labor in this country. The memoranda have been arranged in three groups, the related subjects being brought together, and are reprinted as bulletins of the United States Bureau of Labor Statistics under the following titles:

BULLETIN NO. 221, HOURS, FATIGUE, AND HEALTH IN BRITISH MUNITION FACTORIES.

Sunday Labor (Memorandum No. 1). November, 1915. 6 pp. [Cd. 8132.]

(Summarized in MONTHLY REVIEW of the U. S. Bureau of Labor Statistics, May, 1916, pp. 66, 67.)

Hours of Work (Memorandum No. 5). January, 1916. 9 pp. [Cd. 8186.]

(Summarized in MONTHLY REVIEW, June, 1916, pp. 77-79.)

Statistical Information Concerning Output in Relation to Hours of Work (Memorandum No. 12). (Report by H. M. Vernon, M. D.) August, 1916. 11 pp. [Cd. 8344.]

(Summarized in MONTHLY REVIEW, December, 1916, pp. 105-119.)

Industrial Fatigue and its Causes (Memorandum No. 7). January, 1916. 11 pp. [Cd. 8213.]

(Summarized in MONTHLY REVIEW, June, 1916, pp. 79-81.)

Sickness and Injury (Memorandum No. 10). January, 1916. 10 pp. [Cd. 8216.]

(Summarized in MONTHLY REVIEW, June, 1916, pp. 88-90.)

Special Industrial Diseases (Memorandum No. 8). February, 1916. 8 pp. [Cd. 8214.]

(Summarized in MONTHLY REVIEW, June, 1916, pp. 83-88.)

Ventilation and Lighting of Munition Factories and Workshops (Memorandum No. 9). January, 1916. 9 pp. [Cd. 8215.]

(Summarized in MONTHLY REVIEW, June, 1916, pp. 81-83.)

The Effect of Industrial Conditions Upon Eyesight (Memorandum No. 15). October, 1916. 8 pp. [Cd. 8409.]

(Summarized in MONTHLY REVIEW, April, 1917, pp. 538-540.)

BULLETIN NO. 222, WELFARE WORK IN BRITISH MUNITION FACTORIES.

Welfare Supervision (Memorandum No. 2). December, 1915. 7 pp. [Cd. 8151.]

(Summarized in MONTHLY REVIEW, May, 1916, pp. 68, 69.)

Industrial Canteens (Memorandum No. 3). November, 1915. 7 pp. [Cd. 8133.]

(Summarized in MONTHLY REVIEW, May, 1916, pp. 69, 70.)

Canteen Construction and Equipment (Memorandum No. 6). (Appendix to No. 3.) January, 1916. 7 pp. and plates. [Cd. 8199.]

(Summarized in MONTHLY REVIEW, June, 1916, p. 91.)

Investigation of Workers' Food and Suggestions as to Dietary (Memorandum No. 11). (Report by Leonard E. Hill, F. R. S.) August, 1916. 11 pp. [Cd. 8370.]

(Summarized in MONTHLY REVIEW, January, 1917, pp. 56, 57.)

Washing Facilities and Baths (Memorandum No. 14). August, 1916. 8 pp. [Cd. 8387.]

(Summarized in MONTHLY REVIEW, January, 1917, pp. 150, 151.)

BULLETIN NO. 223, EMPLOYMENT OF WOMEN AND JUVENILES IN GREAT BRITAIN DURING THE WAR.

Employment of Women (Memorandum No. 4). January, 1916. 10 pp. [Cd. 8185.]

(Summarized in MONTHLY REVIEW, June, 1916, pp. 74-76.)

Juvenile Employment (Memorandum No. 13). August, 1916. 8 pp. [Cd. 8362.]

(Summarized in MONTHLY REVIEW, December, 1916, pp. 92-97.)

In the present bulletin the memoranda relating to hours of labor and industrial fatigue are reproduced in full, preceded by a summary of the more important suggestions and recommendations of the committee.

There has been added also the report of the Treasury agreement of March 17, 18, and 19, 1915, between representatives of the British Government and representatives of the trade-unions, in which it was agreed in behalf of the trade-unions that all trade-union or shop rules and customs tending to restrict production or to limit the employment of semiskilled or female labor should be suspended for the period of the war, the Government on its part agreeing to require all contractors and subcontractors on munitions or other war work to bind themselves to restore such trade-union rules and customs after the war. It was further agreed that machinery should be provided for the prompt settlement of all labor disputes and that no dispute should be allowed to result in a suspension of work.

The text of the Munitions of War Act, 1915, and the Munitions of War (Amendment) Act, 1916, under which the terms of this agreement were enacted into law, is also given.

SUMMARY OF THE COMMITTEE'S CONCLUSIONS.

Upon the subject of *Sunday labor* (Memorandum No. 1), the evidence before the committee led them to hold that "if the maximum output is to be secured and maintained for any length of time a weekly period of rest must be allowed. Except for quite short periods, continuous work, in their view, is a profound mistake and does not pay—output is not increased. On economic and social grounds alike this weekly period of rest is best provided on Sunday.

"The committee desire to state that, in their opinion, the foremen and the higher management even more certainly require definite periods of rest. These individuals have never spared themselves, they carry a heavy burden of responsibility and they can not be replaced. * * * It is of primary importance in the interests of the nation that they should be allowed that rest which is essential to the maintenance of their health.

"In conclusion, the committee desire to emphasize their conviction that some action must be taken in regard to continuous labor and excessive hours of work if it is desired to secure and maintain, over a long period, the maximum output. To secure any large measure of reform it may be necessary to impose certain restrictions on all controlled establishments, since competition and other causes frequently make it difficult for individual employers to act independently of one another."

In the preparation of the memorandum on *Hours of work* in munition factories (Memorandum No. 5) the committee seem to have been influenced by consideration of what is immediately practicable regarding the health of the worker in relation to a maximum output, in view of exceptional conditions entailed by the war. It is suggested that an increased number of hours may be obtained by overtime or by a system of shifts and that the committee greatly prefers the latter, although recognizing that it is impracticable to establish shifts universally. The committee's objections to overtime, briefly stated, are: (1) It is liable to impose too severe a strain upon the workers, which adversely affects the rate of production and quality of output during the whole period of work as well as during the hours of overtime; (2) it frequently results in a large amount of lost time, which is attributed to workers becoming exhausted and taking a rest, and also to sickness; (3) it imposes a very serious strain upon the management, the executive staff, and foremen, since they can not take days off, like the ordinary worker; (4) it is liable to curtail

unduly the period of rest and sleep available for those who have to travel long distances to and from their work, a matter of special importance in the case of young persons; (5) the fatigue entailed increases the temptation to men to indulge in the consumption of alcohol.

Admitting that overtime must continue, the committee suggested definite restrictions to govern it. For adult male workers the committee recommends:

1. The average weekly hours (exclusive of meals) should not exceed 65 to 67, including overtime. Hours in excess of 65 should only be worked for short periods and to meet sudden and unexpected circumstances. It may be desirable to differentiate to some extent between different kinds of work, and to fix a rather low limit of hours for work requiring close individual attention.

2. Where practicable, the overtime should be concentrated within three or four days in the week, which should preferably not be consecutive.

3. Where overtime is worked, it is specially important that there should be no Sunday work.

As respects women, the committee expresses the belief that the strain of long hours is serious and that conditions of work in excess of the normal legal limit of 60 hours a week ought to be discontinued as soon as practicable, although little objection is seen to such moderate overtime during the week as can be compensated for by an earlier stop on Saturdays. The committee feels that the need for overtime among women and girls is much less pressing than it is for men, and that wherever practicable the system should be abandoned in favor of shifts. Although it is recommended that boys should be allowed to be employed overtime up to the maximum suggested for men, it is thought that every effort should be made not to work boys under 16 more than 60 hours a week.

Although work on shifts involves night work, the committee makes it clear that night work is not to be regarded as a good thing in itself and offers the following objections to the system:

1. It is uneconomical. Though wages are paid at a higher rate, the rate of output, more particularly during the last two or three hours of the 12-hour shift, is generally lower.

2. Supervision is frequently unsatisfactory.

3. Conditions of lighting are seldom so good as in daytime and make fine work more difficult.

4. Workers experience great difficulty in sleeping by day.

5. The unfamiliar meal hour makes it difficult for the workers to consume substantial food, and their digestion is liable to become deranged.

In its special study of *Output in relation to hours of work* (Memorandum No. 12) the object of the committee was to ascertain the hours of employment most likely to produce a maximum output over periods of months or even years. It held that output can not be maintained at the highest level for any considerable period if the

conditions were such as to lead to excessive fatigue and to deterioration in the health of the workers. The committee's investigations covered operations of distinctly different character, some demanding heavy manual labor, others of a light, more or less sedentary, nature. It was found that the time schedule producing the maximum output varied with the character of the operation.

The committee found that for men engaged in very heavy labor the maximum hours of actual work yielding the most effective results appear to be 56 or less per week, for men engaged in moderately heavy labor probably 60 per week, while for men and youths engaged in light labor, such as tending semiautomatic machines, probably 64 hours per week should be the maximum.

As a method of speeding up production, the committee recommended the careful regulation of rest pauses. It was found that the operatives, if left to themselves, took rests at irregular and often unsuitable times, hence it would be much better if the rest pauses were chosen for them. For instance, a 10-minute break in the middle of the morning and afternoon spells during which the operatives remained at their machines, but took tea or other nutriment brought them by boys or by traveling canteens, has been found a valuable aid to output. Some types of work need longer and more frequent rest pauses than others, and the best time can only be determined by experience. After being fixed, they should remain compulsory and rest pauses at other times be checked so far as possible.

The committee's study of *Industrial fatigue and its causes* (Memorandum No. 7) is closely related to its three memoranda dealing with hours of labor. The committee had the benefit of studies of fatigue made by the Home Office¹ and by a committee of the British Association for the Advancement of Science,² and the committee's report may be regarded as the summing up of these various studies of fatigue and its own studies of hours of labor. The committee again emphasize the importance of the regulation of hours and of daily and weekly rests, made with due consideration of the character of the work performed.

The committee in recording their conclusions say: "The committee are bound to record their impression that the munition workers in general have been allowed to reach a state of reduced efficiency and lowered health, which might have been avoided without reduction of output by attention to the details of daily and weekly rests.

¹ Great Britain, Home Office. Second interim report on an investigation of industrial fatigue by physiological methods, by A. F. Stanley Kent, M. A., D. Sc., professor of physiology in the University of Bristol. London, 1916. 76 pp., 18 charts.

² British Association for the Advancement of Science. "The question of fatigue from the economic standpoint." Interim report of the committee, Manchester, 1915. 67 pp. British Association for the Advancement of Science. "The question of fatigue from the economic standpoint." Second interim report of the committee, Newcastle, 1916. 24 pp. See MONTHLY REVIEW of the U. S. Bureau of Labor Statistics, December, 1916, p. 97.

The signs of fatigue are even more noticeable in the case of managers and foremen, and their practical results are probably more serious than in the case of the workmen.

"It is of great importance to note that a special and strenuous voluntary effort in labor, if it be maintained under a badly arranged time-table of work and rest, does not necessarily bring increased output over a long period, however praiseworthy the intention of effort may be. Under wrong conditions of work, with excessive overtime, it is to be expected, indeed, that some deliberate 'slacking' of the workers might actually give an improvement of output over a period of some length by sparing wasteful fatigue, just as the 'nursing' of a boat crew over a part of a long course may improve their performance. It can not under such circumstances be said that a workman so restraining himself, consciously or unconsciously, is doing more to damage the output, on the whole, than the employer who has arranged overlong hours of labor on the baseless assumption that long hours mean high output."

In its report on *Sickness and injury* (Memorandum No. 10) the committee pointed out certain injurious conditions which should be guarded against as likely to diminish seriously the efficiency of the labor force. The injurious conditions enumerated are:

- (1) Excessively long hours of work, particularly by night, if continued, produce fatigue, irritation, and sickness. "You will find," wrote Sir James Paget, "that fatigue has a larger share in the promotion or permission of disease than any other single casual condition you can name."
- (2) Cramped and constrained attitudes or posture during work, which prevent the healthy action of lungs and heart.
- (3) Prolonged or excessive muscular strain, e. g., the lifting of heavy weights, prolonged standing, may produce rupture or varicose veins.
- (4) Machinery accidents.
- (5) Working in unventilated or insufficiently ventilated workshops predisposes to disease and gravely interferes with individual energy and physical capacity. The effect of continuously working in a stagnant or polluted atmosphere is not trifling or insignificant.
- (6) The air, even if fresh, may be too hot or too cold, too humid or too dry; either extreme should be avoided to insure reasonable bodily comfort and the most efficient work.
- (7) Imperfect lighting, whether by day or night, conduces to eyestrain and headaches.
- (8) Working with or in the presence of gases, vapors, poisons, and irritating substances (e. g., "doping") may lead to direct poisoning.
- (9) Dust produced in certain industries, unless effectually safeguarded, may induce lung diseases.
- (10) The manufacture and use of high explosives involve risk to the workman.

Equally important with these influences, in the opinion of the committee, is the predisposition to disease arising from a failure to give proper attention to personal hygiene. In commenting upon

these influences likely to impair industrial efficiency, the committee pointed out that, "in the past, when the supply of labor was plentiful, the necessity for a study of the influences which affect human efficiency may have escaped recognition, but to-day, when skilled labor is scarce, the necessity is obvious. To conserve energy and efficiency is, other things being equal, the way to improve output."

For the purpose of remedy and treatment, the committee finds two elementary principles; namely, that prevention is better than cure, and that for treatment to be most effective it must deal with the beginnings of disease. The committee recommends, as a preliminary safeguard, the medical examination of all workers on their admission to the factory, in order to secure, as far as may be, their initial physical fitness for employment. In the opinion of the committee, the factory management has two further duties in the matter: First, they must reduce to a minimum any unfavorable conditions obtaining in the plant, providing proper sanitary conditions and accommodations, safeguarding machinery, controlling hours of labor, furnishing canteen facilities, and securing sufficiently warmed, lighted, and ventilated workrooms; second, they must make arrangements for an adequate medical and nursing scheme.

The committee points out the urgent necessity and value of first-aid work because of the increased number of accidents due to the abnormal demands of munitions work. To meet these increased dangers, the committee suggests the adoption of various methods of prevention, such as the proper and effective guarding of machinery, the adoption of safety appliances, the proper regulating of dangerous processes, the adequate lighting of the factory, and the more careful cleaning of machinery. The committee emphasizes also the pressing need for the provision of suitable means of treatment, especially first-aid treatment for minor injuries and the instruction of employees in first aid, and the thorough organization of first-aid and surgical provision. Systematic recording of all cases of sickness and accident the committee regards as of the utmost importance in the effective treatment of sickness and injuries.

The committee's report on *Special industrial diseases* (Memorandum No. 8) gives the causes, methods of prevention, and treatment for the principal industrial diseases which have been found to affect munition workers. These diseases are: Poisoning due to lead, trinitrotoluol, tetryl or tetranitromethylanilin, fulminate of mercury, tetrachlorethane, and nitrous fumes. Dermatitis, or eczema, caused by exposure to trinitrotoluol, tetryl, and fulminate of mercury, are also discussed.

The committee emphasizes the importance of facilities for the prompt treatment of all cases of sickness and injury, especially in those establishments where poisonous substances are used.

In its report on *Ventilation and lighting* (Memorandum No. 9) the committee calls particular attention to the importance of adequate provisions for ventilation and lighting, in view of the special conditions under which work in munition factories is carried on at the present time. Efficient ventilation is absolutely essential for the maintenance of the health and comfort, and therefore the efficiency and capacity of the workers. The need of effective methods of ventilation is intensified at this time, not only by the increase in the number of workers, but also by the continuous occupation of shops by day and night. There is under these conditions no interval in which natural ventilation can restore a vitiated atmosphere, and each shift succeeds to the bad conditions left by its predecessor.

The committee calls attention to the fact that bad lighting affects output unfavorably, not only by making good and rapid work more difficult but by causing headaches and other effects of eyestrain. The difficulties of supervision, which are always considerable, are further increased if the lighting facilities of the workshops are insufficient. The committee names as the essentials of good lighting: (1) Adequacy; (2) a reasonable degree of constancy and uniformity of illumination over the necessary area of work; (3) the placing or shading of lamps so that light from them does not fall directly on the eye of the operator when engaged at his work or when looking horizontally across the workroom; (4) the placing of lights so as to avoid the casting of extraneous shadows on the work.

In its report on the *Effect of industrial conditions upon eyesight* (Memorandum No. 15) the committee calls attention to the need of special measures to prevent undue strain upon the eyesight or to reduce the liability to accidents to a minimum. These are: (1) Testing of eyesight of operatives to be employed on close work and supplying them with glasses where necessary; and (2) guarding the eyes from flying particles of metal by the use of goggles.

General measures designed to improve the physical health of the workers and so to enable them to resist the effects of fatigue include the proper lighting of factories, the provision of canteens, and adequate time for rest and sleep.

SUNDAY LABOR.

[Memorandum No. 1.]

To the Right Honorable David Lloyd George, M. P., Minister of Munitions.

SIR: 1. The committee were appointed by you, with the concurrence of the Home Secretary "To consider and advise on questions of industrial fatigue, hours of labor, and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops."

2. Since their appointment in the middle of September, the committee have taken evidence in London and other important centers from employers, representatives of workers, and other interested persons. In addition a large number of factories and workshops situated in different parts of the country have been visited by one or more members of the committee. At such visits the opportunity has been taken to discuss matters with the management, with foremen, and with individual workers. The committee have also had the advantage of the special knowledge and experience already possessed by some members of the committee at the time of their appointment.

3. In the course of their investigations the committee have found that both employers and workers were specially concerned at the present time with the problem of Sunday labor. The committee have been so impressed with the urgency and importance of this question that they have thought it right to submit an interim report dealing with this question at once without waiting until they were in a position to deal also with other questions falling within their terms of reference.

4. The problem of Sunday labor, though materially affected by various industrial questions and the established custom of Sunday rest, is—as regards munition works—primarily a question of the extent to which workers actually require weekly or periodic rests if they are to maintain their health and energy over long periods. Intervals of rest are needed to overcome mental as well as physical fatigue. In this connection account has to be taken not only of the hours of labor (overtime, 12-hour shifts, 8-hour shifts), the environment of the work and the physical strain involved, but also the mental fatigue or boredom resulting from continuous attention to work.

As one manager put it, it is the monotony of the work which kills—the men get sick of it.

5. The great majority of the employers consulted are unfavorably disposed to Sunday labor. Their objections may be broadly classified under three heads:

- (a) *Administrative*.—Supervision is difficult and imposes a severe strain on the foreman; yet deputies are not easy to obtain.
- (b) *Economic*.—Sunday labor means high wages often coupled with increased cost of running the works. Though attendance on Sundays is generally good it is not, for various reasons, always accompanied by a satisfactory individual output. Moreover, Sunday labor is frequently accompanied by bad timekeeping on other days of the week.
- (c) *Religious and social*.—There is a considerable feeling that the seventh day, as a period of rest, is good for body and mind.

Although, therefore, employers generally are opposed to Sunday work, it has been widely adopted, (a) on account of heavy demands for output, or (b) because employers have been forced into it by a desire of their workpeople to obtain the double, or at least increased, pay. When adopted, the hours are often considerably shorter than on an ordinary day. The work may begin later and end earlier; overtime is generally dispensed with. In at least one instance the work is confined to a morning of four hours. Saturday night shifts are frequently abandoned, and Sunday night shifts started at a later hour than usual. On the other hand there are still a number of factories where the hours on Sunday are as long as on other days, or even longer, as in cases where transfer from a 12-hour day shift to a 12-hour night shift is made by working for a continuous period of 18 hours at the change.

6. The committee understand that, in response to the request of employers, the Home Secretary has issued orders permitting Sunday labor by "protected" persons (i. e., women and young persons under 18 years of age) in a limited number of cases. At the present moment, for the whole United Kingdom, there are about 50 orders covering women, girls, and boys, and also about another 30 for boys only. As a rule employment on Sundays has only been sanctioned when the hours of work on other days of the week are moderate, and even when Sunday work has been allowed it has been usual to impose conditions restricting employment as regards individuals, e. g.:

- (a) That women and young persons shall not be employed on two consecutive Sundays;

- (b) That they shall have time off on Saturday;
- (c) That they shall only be employed on Sundays in cases of emergency;
- (d) That they shall be employed for a portion of the day only.

7. Evidence in the form of statistics of output in regard to Sunday labor is hardly obtainable; even where the output of work may be such as would in normal circumstances permit of the collection of such figures, the rapid growth in the number of persons employed, the greater employment of women, the increasing efficiency of inexperienced workers, and other similar causes render comparison difficult, unreliable, or impossible. Even where the requisite data might be available it has not generally been found possible for the management to find the necessary time for its collection and tabulation. The representative of one important firm, however, informed the committee that in one of their shops where heavy machine work was done by men of a good average trade-union type they had recently extended the relief at the week end and so reduced the average weekly hours from $78\frac{1}{2}$ to $65\frac{1}{2}$. Though the normal hours were thus reduced by 13, the average number of hours (60) worked during the three months succeeding the change exceeded the average number of hours ($59\frac{1}{4}$) worked during the six months preceding the change. Moreover, in his opinion, the output per hour was improved. Though accurate figures of this kind are not generally available, statements are made by many employers that seven days' labor only produces six days' output; that reductions in Sunday work have not, in fact, involved any appreciable loss of output, and even the less observant of the managers seem to be impressed with the fact that the strain is showing an evil effect. The loss of time on other days has led an employer to the somewhat paradoxical position of confining Sunday work to those who have attended regularly during the week, i. e., to give a rest on Sundays to those who, in fact, need it least. There is undoubtedly some tendency toward a reduction or discontinuance of Sunday labor. It is becoming increasingly realized that there are limits to hours of labor beyond which no commensurate output is obtained. Perhaps inevitably, employers started their production of munitions by sprinting as if for a short race whereas it is becoming evident that the course will be a long one and that the hours of labor must be so organized as to enable the output to be maintained at a regular level for a lengthy period. This is all the more important in that employers have been compelled to engage many untrained men who lacked both the skill and the reserve of energy and staying power possessed by the regular munition worker.

8. The evidence from the side of the employees is naturally less definite. The trade-union officials seem clearly of opinion that the

men are beginning to get "fed up" and are feeling the need of more rest, to which need is attributed much of the lost time. It is stated that many men continue at work who in ordinary times would be absent on account of ill-health. Though a high rate of wages may have rendered Sunday labor popular in the first instance, the committee are not convinced that this is still everywhere the case. At one important center the representatives of the workers urged the abolition of the long "change over" shifts and the stoppage of all ordinary work on Sundays between 8 a. m., and 8 p. m. They definitely preferred relief on Sunday to relief on Saturday afternoon (though elsewhere the Saturday relief is preferred). An employer in the same place informed the committee that at his factory work was generally stopped from 10 p. m. on Saturday to 6 a. m. on Monday, and that the day shift preferred to work on from 6 p. m. to 10 p. m. on Saturday afternoon in order that they might be set free on Sunday. At another important center the representatives of the workers, while they thought that an immediate stoppage of all Sunday work might lead to trouble over wages, definitely urged that the workers should be given one Sunday off in every two or three. Certainly, whatever difficulties there may have been or still are, the fact remains that a number of prominent employers have succeeded in reducing or abolishing seven days' labor.

9. The evidence before the committee has led them strongly to hold that if the maximum output is to be secured and maintained for any length of time, a weekly period of rest must be allowed. Except for quite short periods, continuous work, in their view, is a profound mistake and does not pay—output is not increased. On economic and social grounds alike this weekly period of rest is best provided on Sunday, and the committee are strongly of opinion that Sunday work should be confined—

- (a) To sudden emergencies, including the occasional making up of arrears in particular sections; and
- (b) To repairs, tending furnaces, etc. (the men so employed being given a corresponding period of rest during some other part of the week).

Speaking generally, the need for this relief from work on Sunday is more urgent for "protected" persons than for adult males, and for men on overtime than for those on double shifts, and the need may also vary somewhat according to the number of hours worked during the week and the environment and character of the work; but the committee consider that the discontinuance of Sunday labor should be of universal application and should extend to all classes of workers, except that where the work must necessarily be continuous special arrangements will be necessary.

10. Should the early stoppage of all Sunday work be considered for any reason difficult, if not impossible, to bring about, the committee trust that it will at least be practicable to lay down the principle that Sunday labor is a serious evil which should be steadily and systematically discouraged and restricted. They suggest that, pending a general discontinuance of such labor, there are various ways in which an important improvement might be effected:

- (a) Where two shifts (one for day and one for night) are worked, to discontinue the practice by which the change from one shift to the other is made by requiring the men to work continuously for a period and a half instead of by closing down on Saturday night or during the period of the day shift on Sunday. Closure on Saturday nights seems desirable even when the change of shift is made less often than once a week, since the night shift seems to be generally regarded as a greater strain than the day shift.
- (b) Where three 8-hour shifts are worked, to omit one or two shifts on Sunday.
- (c) Where workers are employed only during the day with overtime, to reduce so far as possible the hours of work on Sunday.
- (d) To give all workers alternate Sundays off, or at the very least a Sunday off at frequent intervals:
 - (i) By allowing a certain number to get off each Sunday;
 - (ii) By closing completely, say, one Sunday in every two or three;
 - (iii) By closing alternately in particular departments.
- (e) To give another day off in place of Sunday or, at any rate, to let workers on long hours off early on Saturdays or at other times.
- (f) To increase the employment of relief gangs where this can be satisfactorily arranged for, by obtaining either—
 - (i) Relief workers amongst ordinary staff; or
 - (ii) Relief week-end shifts of volunteers.

11. The above conclusions have reference to the hours of labor of workers, but the committee desire to state that, in their opinion, the foremen and the higher management even more certainly require definite periods of rest. These individuals have never spared themselves; they carry a heavy burden of responsibility and they can not be replaced. The committee have with regret noted among them obvious signs of overwork. It is of primary importance in the in-

terests of the nation that they should be allowed that rest which is essential to the maintenance of their health.

12. In conclusion, the committee desire to emphasize their conviction that some action must be taken in regard to continuous labor and excessive hours of work if it is desired to secure and maintain, over a long period, the maximum output. To secure any large measure of reform it may be necessary to impose certain restrictions on all controlled establishments, since competition and other causes frequently make it difficult for individual employers to act independently of one another.

Signed on behalf of the committee,

GEORGE NEWMAN.

E. H. PELHAM, *Secretary.*

NOVEMBER, 1915.

HOURS OF WORK.

[Memorandum No. 5.]

In the preparation of this memorandum the committee have necessarily been influenced by considerations of what is immediately practicable regarding the health of the worker in relation to a maximum output, in view of the exceptional conditions entailed by the war. The limits of hours which they propose are based on the expectation that the war will be of long duration, and are such as they think can reasonably be continued over a protracted period. Many divergent factors have had to be weighed one against another and a number of the suggestions made are the resultant of a balance of considerations. The memorandum is directly concerned only with the hours of employment of workers engaged on the production of those munitions of war for which the ministry are directly responsible; it is not, for example, concerned with the hours in the shipbuilding or textile trades. One aspect of the question of hours of employment has already been considered in the committee's memorandum on "Sunday labor" (Memorandum No. 1¹); but even though a weekly or Sunday rest be conceded, important questions will remain as to how far an extension of the working hours during the week can be maintained and made to secure a maximum of output over a long period of time. An increased number of hours may be obtained either by overtime (by which is meant a lengthening of the normal daily hours of work) or by a system of shifts. The committee greatly prefer the latter alternative, but recognize that, for reasons which will be discussed later, it is impracticable to establish shifts universally.

OVERTIME.

2. Overtime is commonly justified on the ground that no other arrangement is possible owing to a dearth of workers and to the difficulties of increasing plant, and it is contended that, though the output per hour may not be maintained, the system does result in increased production. It should be noted that as the most highly skilled workers (tool and gauge makers, tool setters, etc.) are the most difficult to obtain, they have been most generally employed on overtime, and have frequently had to work exceedingly long hours. At one time cases of men working as much as 90 hours per week were common; more recently there has been a tendency to reduce hours, but even so, weekly totals of 70 to 80 hours are still frequent.

Some overtime amongst this class is no doubt inevitable, but the committee are satisfied that hours such as these can not be worked with impunity, and they most strongly urge that every effort should be made, either by "dilution" of labor or otherwise, to extend the shift system to this branch of the industry as rapidly as possible.

3. The objections to overtime may be briefly stated as follows:

- (1) It is liable to impose too severe a strain on the workers. Many witnesses assert that while for an emergency overtime is effective, after a period the rate of production tends to decrease and the extra hours to produce little or no additional output. Moreover the quality of the output may be adversely affected during the whole period of work and not only during the hours of overtime.
- (2) It frequently results in a large amount of lost time. In part this is to be attributed to the workers becoming exhausted and taking a rest, and also to sickness, noticeable chiefly amongst the older men and those of weak constitution.
- (3) It imposes a very serious strain upon the management, the executive staff, and the foremen, both on account of the actual length of the hours worked and the increased worry and anxiety to maintain output and quality of work. These men can not take days off duty like the ordinary workers.
- (4) It is liable to curtail unduly the period of rest and sleep available for those who have to travel long distances to and from their work, a matter of special importance in the case of young persons.
- (5) The fatigue entailed increases the temptation to men to indulge in the consumption of alcohol; they are too tired to eat and seek a stimulant.

4. The committee have not found that as yet the strain of long hours has caused any serious breakdown among workers, though many general statements indicative of fatigue have been received by the committee; in particular there is medical evidence to the effect that the long hours are beginning to make themselves felt upon the older men and upon those who suffer from physical infirmity. It is noticeable, too, that there is a general tendency toward a reduction of hours. There is good reason for believing that the increased pay and the better food that workers have been able to enjoy in consequence have helped to counteract the strain of long hours, and there is little doubt, too, that both men and women have been stimulated to make a special effort by an appreciation of the national importance

of their work. These influences have been thus summarized by a trade-union official:

- (1) Will power. Men have continued at work in a condition that (under ordinary circumstances) would have put them off for a week or two. Even when a man comes off for a time he is anxious to get back again as quickly as possible. I have had one or two cases of serious breakdown. The main factor is that practically all the men want to do their best.
- (2) Better wages mean better food for a large number of men with families, and they mean a little better provision for those families, which again reacts upon the man's health and his work. In these cases it is not so much the saving or possibility of saving money, but the satisfactory spending of it which is the factor of importance.
- (3) The possibility of getting more money has also its effect. You read much about the slacker. There is quite a large proportion of workmen really too anxious for overtime—employers will corroborate—even under normal conditions.

It would be a mistake, however, to depend too largely upon the operation of influences of this kind, or to hope that they can continue indefinitely to be effective against fatigue. The committee are satisfied that if men are asked to work for 15 hours a day for weeks and months on end (as is the case now in certain areas) one of two results must follow. Either the health of the workers will break down or they will not work at full pressure. In either case output must suffer. It must be remembered, moreover, that the problem to be considered is not so much whether the workers have been able to withstand the strain of extra hours up to the present, as whether they are likely to continue to withstand it under similar conditions for a further protracted period.

5. Amongst the executive and foremen there is already evidence of considerable fatigue, and numerous instances have been brought to the notice of the committee where men of this class have had to be allowed special holidays to enable them to recuperate. It is hardly necessary to emphasize the importance of maintaining the health and physical efficiency of this class, upon whom depends principally the organization and discipline of the works. In some instances it has been found possible to arrange for members of the executive and foremen to share the duty during hours of overtime, an obviously desirable arrangement where it can be managed.

6. While, then, the committee recognize that overtime must continue, they suggest that it should be subject to certain definite restrictions somewhat on the lines indicated in the following paragraphs. They feel, however, that a final judgment upon overtime must be reserved until there has been an opportunity to observe the effects of restricted Sunday work, a reform which they hope will follow as a

result of the recommendation put forward in their first memorandum.

7. *Adult males*.—There is an extraordinary conflict of opinion as to the number of hours that can profitably be worked. On the one hand the advocate of the 48-hour week is emphatic in his view that this is the maximum a man can be employed effectively. "All overtime is bad," said the representative of one large firm, "we only work if driven to do so by urgent demands from the ministry, and even then our men become disorganized, and it is doubtful if our output is in any way increased." On the other hand, those who are employing their workers for 15 hours a day, sometimes with Sunday work in addition, state with apparently equal confidence that such hours are not excessive, that they have been worked in times of peace, and that they can not be reduced without loss of output. It is noticeable that amongst those in favor of shorter hours are employers who have given the most careful study to the question of industrial fatigue and scientific management, and it is at least significant that, so far as the committee can learn, no employer who has once adopted the shorter scale of hours ever desires to return to a longer period. If, however, the 48-hour week is to be made a success, the reduction of hours must be accompanied by a reorganization in factory management, which it would be difficult or impossible to carry out at the present time. Amongst those who favor the longer hours are to be found some of the largest employers of labor. While the committee hesitate to criticize the action of firms of such great experience, it seems self-evident that men can not work continually for 15 hours a day with good effect, more particularly when, as is often the case at the present time, there has to be added to the day's labor a journey of an hour or more to and from the works. The hours thus described—6 a. m. to 9 p. m.—appear to have their origin in trade custom—they add "a quarter" to the ordinary day's work and have been adopted in normal times to meet temporary trade pressure. The pressure now, however, is not temporary, and preparation must be made for a prolonged period of overtime. "The longer the hours, the greater the amount of broken time," is a maxim that has been repeated again and again, and the committee feels that much of the broken time is due to a sense of fatigue which leads the workers to take time off for rest. There remains, however, between these two courses a *via media*, which the committee believe to be satisfactory and which they find has in its favor a great body of public support. It allows a maximum of 10 to 12 hours of overtime a week. One large employer, who is also engaged in organizing some of the national factories, expressed the view that a 65-hour week averaged over a period of time, with a maximum of 80 hours in any

one week, was as much as men ought to be asked to work. Another put the limit at 2 hours' overtime a day. The following statement by a trade-union representative is to the same effect:

Where there is overtime beyond two hours daily there is evidence of fatigue and men can not be employed economically, from health and production point of view, on continuous overtime of three and four hours daily. Fatigue is rarely reaching the point of breakdown, but does affect health and production, and in my opinion will manifest itself later. In some cases where such overtime is worked, apart from night shifts, men are allowed one early night per week, and I think this is wise and economically sound.

Again, in the agreement between the Engineering Employers' Federation and the Engineering Trade Unions a limit of 32 hours of overtime per month was adopted, while the Home Office general order for munition factories (which, though it applies directly only to the labor of women and young persons, affects indirectly the hours of work of male adults, since their work is generally dependent upon that of the protected persons) provides for a maximum of $67\frac{1}{2}$ hours a week and has been found to meet the needs of the great majority of the employers. It is evident that within the limits of prescribed hours the speed of work and the energy exerted differ widely; the committee, however, think that such hours can not reasonably be exceeded without affecting the physical efficiency of the workers; and accordingly, on the facts at present before them, they make the following recommendations as appropriate to the special conditions imposed by the war:

- (a) The average weekly hours (exclusive of mealtimes) should not exceed 65 to 67, including overtime. Hours in excess of 65 should only be worked for short periods and to meet sudden and unexpected circumstances. It may be desirable to differentiate to some extent between different kinds of work, and to fix a rather lower limit of hours for work requiring close individual attention.
- (b) Where practicable the overtime should be concentrated within three or four days in the week, which should preferably not be consecutive.
- (c) Where overtime is worked it is specially important that there should be no Sunday work.
- (d) The practice prevailing in certain districts of working from Friday morning, all through Friday night, and until noon on Saturday should be discontinued. Such hours may be permissible for short spells, but can not be satisfactory from the point of view either of health or output if continued for indefinite periods.

8. *Women and girls.*—Important as it is that hours of work for men should be kept within reasonable limits, it is essential that

hours of work for women and girls should be even more closely safeguarded. There is a general consensus of opinion (it is indeed beyond dispute) that women are unable to bear the strain of long hours so well as men, and, though there is some divergence of views, opinions as to what hours can profitably be worked vary to a much less extent than was found to be the case in regard to men. The great majority of the employers, when making their applications to the Home Office for exemption orders, have not asked to be allowed to work more than 65 hours per week, but beyond this the committee have been struck by the fact that in many of the works they visited the maximum hours allowed by the orders have seldom been worked continuously. Employers, not unnaturally, have sought permission for a wider limit of hours than is ordinarily necessary or desirable, in order that they may have latitude for dealing with special emergencies, and the Home Office orders were so drawn up as to provide for exceptional occasions of this kind. In order to investigate more closely the effect of long hours upon the health of operatives, the committee have recently instituted a series of intensive inquiries¹ among munition workers. Up to the present, only a few returns relating to women operatives have been collected; but, so far as they go, they do to some extent suggest progressive deterioration of health in proportion as the operatives had been employed for long hours and for long periods.

The committee are satisfied that the strain of long hours is serious, and they are of opinion that continuous work in excess of the normal legal limit of 60 hours per week ought to be discontinued as soon as practicable, though they think that some greater elasticity of hours might be allowed than is provided for by the factory acts, and they see, for instance, little objection to such moderate overtime during the week as can be compensated for by an earlier stop on Saturdays. They recognize, however, that the character of much of the work on which women and girls are engaged is at present such that it may be impracticable to carry this recommendation into effect forthwith, and some reasonable limit of time should be allowed for readjustment. Much necessarily depends upon the character of the employment, upon the conditions (including factory environment and piecework or time-work) under which it is performed, upon the sufficiency of food, upon whether the workers can sit while at work, and upon whether they live close to the factory or have to undergo, in addition to their actual labor, the added strain of traveling in crowded conveyances to and from their work. The committee feel

¹ These inquiries are being conducted by medical women, acting in conjunction with lady inspectors of the Home Office and the National Insurance Commission. Similar inquiries among men are also in contemplation. The validity of such inquiries must largely depend upon their continuance over a considerable period, upon reexaminations and upon the sufficiency of the numbers examined.

that the need for overtime amongst women and girls is much less pressing than it is for men; they are rarely employed on highly skilled work, and where there is still a good reserve of labor there should be little difficulty in gradually introducing shifts, or in other ways redistributing the work among a large number of operatives. They strongly urge that wherever practicable overtime should be abandoned in favor of shifts.

9. *Boys.*—In view of the extent to which boys are employed to assist adult male workers and of the limitation of supply, the committee, though with great hesitation, recommend that boys should be allowed to be employed on overtime up to the maximum suggested for men, but every effort should be made not to work boys under 16 more than 60 hours per week. Where overtime is allowed substantial relief should be insisted upon at the week ends, and should be so arranged as to permit of some outdoor recreation on Saturday afternoon.

SHIFTS.

10. Where shifts can be arranged they are to be preferred to overtime, not only because they involve less strain on foremen and workers, but because they enable the machines to be used for the whole 24 hours, and, in addition, produce a better and more uniform rate of output. Shifts are either double (day and night) or consist of three 8-hour periods.

11. *Day and night shifts.*—These are not always of equal length. Where the normal hours of work during the day are less than 12 (e. g., 6 a. m. to 5 p. m.) it is usual to place the remaining hours in the night shift. The ordinary daily hours have been fixed after prolonged struggles and negotiations between operatives and employers, and it has no doubt been thought advisable not to interfere with customs thus established; it may be argued, too, that by making the night shift somewhat longer than the day shift the total weekly hours for each shift are more nearly equalized, since there are usually fewer night shifts than day shifts. At the same time the committee can not but feel some regret that the strain of the night work should be increased by these additional hours, and they think it desirable that whenever practicable the night shift should not exceed the day shift in length. The two shifts are generally continuous and sometimes even overlap to enable the work in hand to be transferred to the new set of workers. It has been observed, however, that in some cases there is a short interval between the two shifts, which affords opportunity for cleaning and ventilating the shops, a matter to which the committee attach much importance.

12. While it is no part of the duty of the committee to express any views on the "8-hour day" as understood in the engineering

trades, the system of 8-hour shifts is one that has come very forcibly under their attention. There are undoubtedly certain advantages to be derived from this system of hours. They involve little or no strain upon the workers; the periods during which machinery must stand idle for meals are very much reduced, while significant statements have been put before the committee claiming beneficial effects upon output. Unfortunately, apart from any other reason, a shortage of workmen and the difficulties of supervision, as well as problems of housing and transit, to a large extent exclude 8-hour shifts from practical consideration, so far as male workers are concerned. The difficulties in the case of women are much less, and it is the more important to establish the 8-hour shift, in their case, because there are being attracted into munition works at the present time women who hitherto have been entirely unaccustomed to factory life, and who are on that account not unlikely to find the strain of a 12-hour day too great, while they could work readily and effectively through an 8-hour period.

Mention should also be made of a variant of the 3-shift system under which the first day shift works from 6 a. m. to 10 a. m. and again from 2 p. m. to 6 p. m., while the second day shift works from 10 a. m. to 2 p. m. and again from 6 p. m. to 10 p. m. This system is stated to produce a larger output because no intervals for meals are required and because the worker benefits from the four hours' interval, but it appears to be unpopular with the workers, chiefly because of the difficulty of occupying satisfactorily the four hours' interval, which is too short to allow the worker to go home and take up other occupation and too long to be spent in idleness at the works. The committee consider that the system should be discouraged, even where facilities for rest and recreation are provided at the factory, and they regard it as altogether unreasonable where such facilities do not exist.

13. *Adult male workers* are almost universally employed on double shifts. They appear on the whole to be standing the system well, more particularly where relief is given at the week ends. The committee see no reason to suggest any change.

14. *Women workers* are employed sometimes on 12-hour and sometimes on 8-hour shifts, but the latter arrangement is becoming, the committee are glad to note, increasingly common. The strain of the 12-hour night shift for women is considerable, even where workers are provided with seats, and the committee consider that the system should be abandoned wherever local difficulties of labor supply, housing, and transit can be overcome, and in no case should the hours worked at night exceed 60 per week. Whatever system of shifts is adopted, girls under 18 should not be employed on a night shift

unless the need is urgent and the supply of women workers is insufficient. In such cases the employment should be restricted to girls over 16 years of age, carefully selected for the work.

15. *Boys*, like the men, are generally employed on 12-hour shifts. It does not seem practical to suggest any change of system, but the committee hope that care will be taken to watch the effect of night work on individual boys and to limit it as far as possible to those over 16.

NIGHT WORK.

16. It has already been stated in paragraph 10 that shifts, where practicable, are preferable to overtime, but the committee do not desire it to be thought that they regard night work as a good thing in itself, and they deem it advisable to set out some of the objections to it which have come under their notice.

(a) It is uneconomical. Though wages are paid at a higher rate, the rate of output, more particularly during the last 2 or 3 hours of the 12-hour shift, is generally lower. The committee feel that this objection would be largely overcome by the workers being afforded an opportunity to obtain suitable refreshment about 4 a. m.

(b) Supervision is frequently unsatisfactory. This is chiefly due to the fact that not infrequently fewer and less experienced foremen are employed at night.

(c) Conditions of lighting are seldom so good as in daytime, and make fine work more difficult.

(d) Workers experience great difficulty in sleeping by day, partly because of the dislocation of the ordinary habits of life and partly because of the noises and disturbances which are almost inevitable in the daytime, except under specially favorable conditions.

(e) The unfamiliar meal hours make it difficult for the workers to consume substantial food and their digestion is liable to become deranged.

17. A question of considerable importance in connection with the shift system is how long the workers should remain on the night shift at any one time. A week is the most common period, more particularly where the three-shift system is in vogue. Elsewhere the changes are sometimes made fortnightly or monthly, and in some instances there is no alternation at all, the workers remaining continuously on day or night work, except for occasional changes amongst individuals carried out for the convenience of the persons concerned. There has been so much divergence of opinion as to the merits of the different systems that the committee have found it difficult to arrive at any definite conclusions. Those who favor the weekly change argue that the strain of the night work and the difficulties of obtaining adequate sleep during the day are such that it is unde-

sirable for workers to remain on night work for more than a week at a time. On the other side it is stated that repeated changes make it more difficult to settle down to either system, and that the night work after the first week becomes less trying, while the ability to sleep by day increases. While on physiological grounds the committee consider that much is to be said for infrequent changes, they think that this is a matter which must be settled locally largely on social considerations, and should be left to individual employers to determine in consultation with their workpeople. Whatever may be settled, provision should be made for the worker to have a period of rest before and after period of the night shift. Change of shift should be effected by dropping one or more shifts and not by working for one and a half periods.

SPELLS AND BREAKS.

18. With certain minor qualifications existing arrangements for spells and breaks are generally satisfactory, and the committee have but few suggestions to make. Where work commences at 6 a. m. the ordinary breaks are half an hour for breakfast, and one hour for dinner. At some factories work only begins at 7 a. m. or 8 a. m., the workers being expected to have had their breakfast before arrival. The committee do not feel that there is any real objection to the system, though the earlier of these two hours is liable to involve a long spell of work, and even if the men have had a good meal before starting the distance to be traveled to work may necessitate a very long period between breakfast and dinner. In such cases a brief interval, when tea can be taken, may prove beneficial. A tea interval is usually allowed for men only when overtime is worked; it usually consists of half an hour, but in some cases it is reduced to a quarter of an hour or 20 minutes. A reduced mealtime of this kind has generally been established in order to enable the workers to get home at an earlier hour, and there is much to be said for it on this account; it affords, however, little enough time to get a meal, and it should only be permitted where arrangements are made for the tea to be actually ready for the workers as soon as they stop work. Women workers are frequently allowed short intervals in the morning or the afternoon or both. It seems to be generally agreed that women can not profitably work long spells without any break or refreshment, and the committee feel that breaks of this kind are to be encouraged. An opportunity for tea is regarded as beneficial both to health and output, and a break in the morning is specially important where women are expected to have breakfasted before starting work.

19. Where double shifts are worked two intervals usually are allowed at night, one of an hour and the other half an hour; but in a

number of cases the first interval is also reduced to half an hour. The committee are very strongly of the opinion that this is a mistake and recommend that intervals amounting to not less than one and one-half hours should be allowed as on the day shifts. Night work is certainly more strenuous than day work, and it is illogical therefore to allow a reduced period for meals and rest during the night. These objections are particularly valid in the case of women, since they often experience difficulty in eating a proper meal at night unless they are allowed plenty of time, and they appear to benefit in other ways by the opportunity of rest afforded by the longer interval. It has been argued that as the workers have nowhere to go during the night, an hour at a time is too long. This objection would, however, be overcome by the adoption of two intervals of three-fourths of an hour each, which would allow adequate time for taking a meal and at the same time not make either interval unnecessarily long. The committee think it important that there should be some opportunity for rest and refreshment, more particularly in the case of women, between about 3 a. m. and 4 a. m. The postponement of the second break until this hour helps the workers to carry on through the trying hours at the end of a night shift.

20. Where women are employed on 8-hour shifts an interval of half an hour is allowed, occasionally with a brief second interval. Provided that no considerable part of the time has to be spent in the preparation of the meal this interval appears to be sufficient.

HOLIDAYS.

21. The committee consider it most important that the ordinary factory holidays should not be interfered with. They afford a definite break in a long period of strain, and a favorable opportunity for recuperation. This opportunity could be used to fuller advantage if adequate traveling accommodation and railway facilities were provided for conveying large numbers of workers to convenient health resorts and holiday centers.

Signed on behalf of the committee,

GEORGE NEWMAN, M. D.,
Chairman.

E. H. PELHAM, *Secretary.*
JANUARY, 1916.

OUTPUT IN RELATION TO HOURS OF WORK.

REPORT BY H. M. VERNON, M. D.

[Memorandum No. 12.]

1. In a previous memorandum (No. 5) the committee recommended that the average weekly hours of labor, including overtime, should not exceed 65 to 67 for men, and 60 hours for women. They suggested that it might be desirable to differentiate to some extent between different kinds of work, but they did not offer any detailed information, because at the time they had not sufficient data at their disposal to warrant definite conclusions. In order to remedy this deficiency, special investigators, including myself, have been engaged for many months past in collecting statistics concerning output in relation to hours of labor at a number of munition works, and I am now bringing forward a portion of the data which I have obtained as they appear to me, not only to afford information concerning the most suitable hours of labor in certain specific munition operations, but also to suggest some of the principles which should be followed in fixing the hours of labor for munition work in general.

2. I understand that the object of the committee is in many ways similar to that of the managers of munition works, and is to ascertain the hours of employment most likely to produce a maximum output over periods of months, or maybe even of years. They hold that output can not be maintained at the highest level for any considerable period if the conditions are such as to lead to excessive fatigue and to deterioration in the health of the workers. If health and physical efficiency are maintained they would raise no a priori objections to any given number of hours, however long. Further, in considering the relative value of, say, a 65-hour week as compared with a 55-hour week the question is whether the former or the latter will produce the greater total weekly output, rather than whether any extra cost involved by the additional output is justified by the economic or military conditions existing at any given time.

3. The statistical data collected with one exception concern the output of day shifts, and they were collected in large and recently built munition works, where the conditions of labor, such as lighting, warming, ventilation, and the provision of canteens, were as favorable as possible. All classes of operatives were on piecework, they were paid at a high rate of wages, and there were no trades-union

restrictions whatever upon output. Hence there was every possible stimulus for them to exert their maximum powers of production. It is more convenient to describe first the data obtained relating to the output of women, as one group of them is specially complete.

WOMEN ENGAGED IN MODERATELY HEAVY LABOR.

4. The complete series of output data just referred to concerns women engaged in turning aluminum fuse bodies. The operatives were standing all day at capstan lathes and had to subject each fuse body to seven successive boring and cutting operations. These operations required close attention throughout and some delicacy of manipulation, so that no relaxation of effort was permissible during the actual turning. Nearly 200 operatives were engaged on the work, but for the purposes of statistical analysis the output of only 100 of them could be considered. None were included unless they had attained their maximum output (which statistical examination of individual output showed was attained after 3 weeks' experience) and were engaged on the operation for 15 or more weeks out of the 24 weeks of the statistical period dealt with. For many months previous to this period the hours of labor had usually been $77\frac{1}{2}$ per week, except that in the second week of each month there was no Sunday labor, or the hours were reduced to $69\frac{1}{2}$ per week. From Table I we see that in the 6-week period just before Christmas the actual hours of work averaged 68.2 per week, or 6.6 hours less than the nominal hours (74.8 hours). Taking the average hourly output of fuse bodies as 100, the total (relative) output per week comes to 6,820. The next fortnight was much broken by the Christmas holiday. This amounted practically to a week if the days taken without permission be added to those officially sanctioned. It will be noted that in the week and a half before this holiday the output rose distinctly above the previous average (viz, 6 per cent), but in the half week immediately following it fell considerably below the average (viz, 11 per cent). Both of these variations form a typical feature of output data in relation to holidays, while another typical feature is the considerable and persistent rise which follows on a holiday. In the present instance this rise amounted to 11 per cent more than the average for the pre-Christmas period, or the total output reached its absolute maximum of 7,615 per week. The beneficial effects of the holiday upon output undoubtedly lasted four weeks and probably more, but the reduction in the hours of labor from January 24 onward precluded the possibility of tracing it further. After a 4 days' holiday at the beginning of August the output of a smaller group of the operatives, 40 in number, remained high for 5 weeks and was 7 per cent greater than the average output during the next 8 weeks.

TABLE I.—ONE HUNDRED WOMEN TURNING FUSE BODIES.

Week ending—	Actual hours of work per week.	Nominal hours of work per week.	Hours of broken time per week.	Relative output per working hour.	Hours of work multiplied by relative output.	Remarks concerning output.	
Nov. 14	62.0	{ 67.5 75.5 75.0 77.2 76.2 77.3 46.0	{ 5.5 6.7 8.3 6.3 7.1 5.5 4.2	{ 98 99 102 96 99 107 105 89	100	6,820	Hourly output fairly steady.
Nov. 21	68.8						
Nov. 28	66.7						
Dec. 5	70.9						
Dec. 12	69.1						
Dec. 19	71.8						
Dec. 26	41.8						Typical rise in hourly output before holiday.
Jan. 2	32.8						
Jan. 9	65.2	{ 69.3 77.2 76.3	{ 4.1 6.9 6.0	{ 113 107 112	111	7,615	Subsequent considerable increase of hourly output, whilst total output rises to a maximum, 12 per cent greater than that of pre-Christmas period.
Jan. 16	70.3						
Jan. 23	70.3						
Jan. 30	62.4	{ 68.5 66.5	{ 6.1 5.7	{ 111 102	107	6,591	Reduction of hours of labor from 74.3 to 67.5 has no immediate effect on hourly output, hence a considerable reduction of total output.
Feb. 6	60.8						
Feb. 13	49.2	{ 52.0 52.0 66.5 66.5 66.5 64.8 66.5 66.5 66.5 49.5	{ 2.8 4.4 4.3 3.7 4.4 6.1 6.2 3.6 3.6 2.5	{ 108 106 118 125 127 121 121 126 126 125	123	7,343	Effect of shorter hours of labor now established and hourly output reaches a maximum. Total output 8 per cent greater than in pre-Christmas period.
Feb. 20	47.6						
Feb. 27	61.4						
Mar. 5	62.2						
Mar. 12	54.8						
Mar. 19	62.1						
Mar. 26	60.4	{ 59.7 60.4 58.5 66.5	{ 4.6 6.1 6.2 3.6	{ 121 121 121 126	123	7,343	Typical rise in hourly output before holiday (Easter).
Apr. 2	58.6						
Apr. 9	54.9						
Apr. 16	62.9						
Apr. 23	47.0						

5. The output data of Table I indicate that the beneficial effect on output of a reduction in the weekly hours of labor from 74.3 to 67.5 was not immediately manifest. Even a reduction to 52 hours seems to have no influence, but this was owing to a temporary shortage of material. From February 27 onward the hours of labor were 66½ per week (or 58½ in the second week of each month, when there was no Sunday labor), and we see that during a period of eight weeks the hourly output now averaged 23 per cent more than in the pre-Christmas period. The total output is 7,343 per week, or 8 per cent more than in the pre-Christmas period, in spite of the hours of labor being nominally 10.5 less, and actually 8.5 less. It is probable that the 60 hours worked per week were still too many to give the best total output, but at least they justify the statement that in order to attain a maximum output women engaged in moderately heavy manual labor should not work for more than 60 hours per week. Observations adduced below suggest that an equally good total output could be maintained if the actual working hours were reduced to 56 or less per week.

6. It might be thought that the great improvement in hourly output under the shorter hours régime was due, partly or wholly, to increased skill of the operatives or improvements in the machinery. Neither of these hypotheses can be substantiated. On classifying the operatives into two groups, according as they had been engaged

in turning fuse bodies for about five months previous to the statistical period dealt with, or for about one and a half months on an average, the hourly output of the former group was found to be 1 per cent less than that of the latter group during the pre-Christmas period, and 1 per cent more than it was during the spring period, or in other words, it was the same within the limits of chance error. As regards the other alternative, no change had been made in the tools, the machinery, the nature of the operation, or the quality of the alloy used during the statistical period dealt with, or for $4\frac{1}{2}$ months previous to it.

7. Further proof of the advantage of shorter hours was afforded by the output data of some of the operatives on an earlier occasion. One group of them, 17 in number, worked only 51.8 to 62.6 hours per week for five weeks in June and July, and during the last three weeks of this period their hourly output was 18 per cent greater than that of another group of 14 operatives who were working the usual long hours. Subsequently, when both groups worked the same long hours, their output was identical.

BROKEN TIME AND SICKNESS.

8. It will be seen from Table I that the operatives lost on an average 6.6 hours per week of "broken" time before Christmas and 4.6 hours per week in the final 8-week period, or that they lost practically half a day per week in this way. But even this does not represent by any means the total time lost, for I have put in a separate category such time as was presumably lost by indisposition. I have made the arbitrary assumption that operatives who put in less than 45 hours per week of actual work out of a nominal $58\frac{1}{2}$ or more did so because of sickness rather than slackness, and I have excluded them in calculating the broken time data quoted in the table, though I retained them when calculating the output of fuse bodies per working hour. In the 6-week pre-Christmas period 4.1 per cent of the weeks worked by the operatives were "short" weeks of less than 45 hours, the average time of actual work amounting to 30.2 hours per week. In addition, the operatives were absent altogether for 2.1 per cent of the weeks. Sickness increased considerably after Christmas, for in the 5-week period, January 3–February 6, 5.7 per cent of the weeks were short weeks, and 3.6 per cent of them were absent weeks, whilst in the 7-week period, February 21–April 9, no less than 12.4 per cent of the weeks were short weeks (averaging 28.6 hours), and 5.4 per cent of them were absent weeks, in spite of the fact that the nominal hours of labor were 10.8 less than in the pre-Christmas period.

9. There can be no doubt that the frequent occurrence of these short and absent weeks was due very largely to fatigue resulting from the strain of the heavy lathe work, for women engaged in light sedentary occupations showed only about a third as many lapses. I was able to obtain data concerning the timekeeping of no less than 400 women and girls engaged in the sedentary occupations of viewing, gauging, and assembling the component parts of fuses, and in Table II are given the average numbers of short and absent weeks observed in the 6 weeks before Christmas, when the nominal hours of labor were 76 per week; in the 5 weeks after Christmas, when they were 75 per week; and in the subsequent 7 weeks (Feb. 7-Mar. 26), when they were 64 per week. Taking first the women of 21 and over, for they alone are strictly comparable in age with the fuse-turning women, it can be seen that in each of the statistical periods dealt with these women put in only about a third as many short weeks as the fuse turners, while they were absent three times less frequently in two of the statistical periods and about half as frequently in the third period.

TABLE II.—WEEKS IN WHICH OPERATIVES WORKED LESS THAN 45 HOURS OR WERE ABSENT.

Age of operatives.	Number of operatives.	Short weeks.			Absent weeks.		
		6 weeks before Christmas.	5 weeks after Christmas.	7 weeks following (Feb. 7-Mar. 26, or Feb. 21-Apr. 9).	6 weeks before Christmas.	after Christmas.	7 weeks following.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
14-16.....	71.....	1.3	1.7	3.6	2.9	1.7	1.4
17-18.....	58 (fuse).....	.3	3.1	5.0	.7	3.8	2.4
19-20.....	96 (gaugers).....	2.4	2.9	6.4	2.6	1.7	3.3
21 and over.....	175.....	1.4	2.1	3.4	.7	2.1	1.8
21 and over.....	100 (fuse turners).....	4.1	5.7	12.4	2.1	3.6	5.4

10. As regards the girls engaged in sedentary work, the table shows that those of 19 to 20 years put in the most short and absent weeks, while those of 14 to 16 put in the least, and in this respect corresponded closely with the women of 21 and over. In Table III are recorded the average hours of broken time observed in the three statistical periods mentioned, and it will be seen that here again the girls of 14 to 16 resembled the women of 21 and over in keeping the best time, while the young women of 19 to 20 were on the whole the worst timekeepers. If comparison be made with the data relating to the fuse-turning women, it will be seen that on an average the adult women engaged in this sedentary work lost only about half as much time as they did.

11. It should be mentioned that these gauging women were not on piece rates like all the others, but were on day rates with the addi-

tion of a large bonus on output if above a certain minimum. Doubtless this system of remuneration tended to improve their time keeping to some extent, though probably not much. Thus the group of women recorded in the next section, who were engaged on the light labor of milling a screw thread, were paid at piece rates, and yet kept time very much better than the fuse-turning women, and not much worse than the gauging women.

TABLE III.—BROKEN TIME OF WOMEN GAUGING FUSES.

Age of operatives.	Number of operatives.	Average hours of broken time per week during—		
		6 weeks before Christmas.	5 weeks after Christmas.	7 weeks following.
14-16.....	71	2.9	3.9	3.2
17-18.....	58	3.9	5.2	3.0
19-20.....	96	3.5	5.9	4.0
21 and over.....	175	2.5	4.7	3.0

12. It is evident that in fixing the number of hours required to produce a maximum output close attention must be paid to the effect of any given number of hours on timekeeping. If an increase in the hours of labor from 50 to 60 per week caused the total output of the operatives, taken as a group, to increase permanently by, e. g., 10 per cent, it would be worth while to adopt these hours, but if after a few weeks of the longer hours it were found that 5 per cent more of the operatives were absent from sickness, and 10 per cent more of them were putting in short weeks of an average of 30 hours instead of the nominal 60 hours, there would be no gain whatever in the total output. Now, it will be seen from Table II that in the third of the statistical periods dealt with 9 per cent more of the fuse-turning women were putting in shorter weeks than of the gauging women, while 3.6 per cent more of them were absent. If, therefore, it were found that by cutting down the hours of actual work of the fuse-turning women from 60 to 56 they were able to reduce their short and absent weeks to those shown by the gauging women, the output would remain practically unchanged. For other and independent reasons, to be mentioned later on, it seems probable that a reduction of the working hours to 56 per week would have no adverse effect on output, and hence there can be little doubt that this number of hours is the absolute maximum for the type of work under consideration, and that if anything it errs on the side of excess.

13. Another point to be borne in mind in fixing hours of labor is the time taken by the operatives to get from their homes to the works, and vice versa. Personal observation leads me to think that the operatives referred to in this memorandum took on an average some-

what less than an hour each way, though I have no exact statistical data on the subject. There was an efficient tram service at their disposal.

WOMEN ENGAGED IN LIGHT LABOR.

14. In the next type of munition work to be described, the operatives were milling a screw thread on the fuse bodies. This necessitated their standing at semiautomatic machines, where they removed one fuse body and inserted another every minute or so. The requisite muscular effort was moderate and simple in character, and took up only about a fifth of the total time required for the operation. For the remaining four-fifths of the time the operative had nothing whatever to do, and so the call upon her attention and her muscles was very much less than that experienced by the operatives previously described. The output of 21 women was investigated over a similar statistical period, but it seems unnecessary to quote the results in full. The average records adduced in Table IV show that the hourly output varied in the same direction as that of the fuse-turning operatives, but to a very much more limited extent. In the 3 weeks after Christmas it was only 6 per cent greater than in the 5 weeks before it, and since the average hours of work were somewhat shorter, the total output remained practically unchanged. A considerable reduction of working hours did not lead at first to any improvement of hourly output, but this established itself after 4 weeks, and was maintained at a steady level during the next 8 weeks. In that the average excess of hourly output amounted only to 9 per cent above that of the pre-Christmas period, the total output became reduced to 4 per cent below it. However, in the 3 weeks after Easter the hourly output improved a further 3 per cent so that the total output reached to within 0.6 per cent of the pre-Christmas value. Probably the best number of hours is something between the limiting values investigated, or about 62 hours, for if the output of 109 per hour were maintained over this time, the total output would work out at 6,758, or slightly above that the the pre-Christmas period.

TABLE IV.—TWENTY-ONE WOMEN MILLING A SCREW THREAD.

Statistical period.	Average hours of actual work.	Average hours of broken time.	Average (relative) hourly output.	Hours multiplied by output.
5 weeks preceding Christmas (Nov. 15-Dec. 19).....	67.4	4.4	100	6,740
2 weeks at Christmas (Dec. 20-Jan. 2).....	44.7	3.5	98	.....
3 weeks after Christmas (Jan. 3-Jan. 23).....	63.7	3.0	106	6,752
4 weeks later (Jan. 24-Feb. 20).....	53.1	2.6	104	5,522
8 weeks later (Feb. 21-Apr. 16).....	59.3	3.6	109	6,463
2 weeks at Easter (Apr. 17-Apr. 30).....	39.4	2.7	108	.....
3 weeks after Easter (May 1-May 21).....	59.8	2.6	112	6,698

MEN ENGAGED IN HEAVY LABOR.

15. The labor assigned to male munition workers is, as a rule, considerably heavier than that assigned to women; but making due allowance for the greater strength and endurance of the man, we find that his output is similarly affected by a reduction in the hours of labor. One of the most fatiguing types of munition work so far investigated by me is that of "sizing." In the sizing of fuse bodies the article is usually subjected to four separate operations, in each of which it is clamped to a small flywheel and handle and is screwed through a steel tap so as to cut a screw thread on it. The operations require no manual dexterity, but they are a great and continuous strain on the muscles of one arm and shoulder and to a less extent on those of the back. The operatives seldom use both arms, as they prefer to keep the "screwing" hand dry and use the other for picking up the oil-covered fuse bodies. The output of a group of 27 operatives was investigated and the mean results are given in Table V. The hours of labor were always shorter than those worked by the women. They never exceeded 71 hours in any one week and seldom included Sunday labor. The hourly output showed a marked drop during the Christmas fortnight and a considerable rise (to 118) for the first week after this fortnight, but the average output during the six weeks after Christmas was only 9 per cent greater than that of the pre-Christmas period in spite of the fact that the weekly hours of labor were 10.4 shorter. Evidently the operatives took a long time to adapt their rate of production to the shorter hours, for the hourly output subsequently averaged 22 per cent in excess of that of the pre-Christmas period. This caused the total output to be no less than 10 per cent greater, and it is probable that even this figure does not represent the full effect of reducing the hours of labor, for after Easter the hourly output improved a further 2 per cent and the total output was increased to 13 per cent above that of the pre-Christmas period. However, a part of this improvement may have been only the temporary effect of the holiday. The week February 14-20 is omitted, as the operatives worked only 41 hours, owing to shortage of material.

TABLE V.—TWENTY-SEVEN MEN SIZING FUSE BODIES.

Statistical period.	Average hours of actual work.	Average (relative) hourly output.	Hours multiplied by output.
6 weeks preceding Christmas (Nov. 8-Dec. 19).....	61.5	100	6,150
2 weeks at Christmas (Dec. 20-Jan. 2).....	38.3	89	.....
6 weeks after Christmas (Jan. 3-Feb. 13).....	51.1	109	5,570
8 weeks later (Feb. 21-Apr. 16).....	55.4	122	6,759
2 weeks at Easter (Apr. 17-Apr. 30).....	41.0	112	.....
3 weeks later (May 1-May 21).....	56.2	124	6,969

16. The broken time is not quoted in the above table, as the nominal hours of labor were rather uncertain. Moreover, the operatives appeared to have had some freedom in selecting their own hours of work. The plan adopted in calculating the weekly hours of actual work was different from that observed in the other data quoted in this memorandum, for all weeks were included in which 20 hours or more were worked. The reason of this change was that these sizers, though they were absent altogether for only 1.8 per cent of the weeks included in the statistical period dealt with, were in the habit of putting in short weeks of 40 hours or less with some frequency. If only those operatives who put in 45 hours or more had been included, the average weekly hours of actual work would have come to about two hours more than the figures quoted in the table.

17. The operatives engaged in sizing fuse bodies were all full-grown men, but certain other sizing operations were performed by youths. The output of one of these groups may be quoted, but in that it concerns only nine operatives, the data are not so reliable as those just recorded. The youths 14 to 17 years of age were sizing steel base plugs, and from Table VI we see that their hourly output was 16 per cent greater in the 4 weeks after Christmas than it had been before, in spite of a slight increase in the hours of labor, whilst it was no less than 42 per cent greater in the 11 subsequent weeks when the hours of labor were reduced from 70.3 to 57. In consequence, the total output attained a value 19 per cent in excess of that of the pre-Christmas period. Even this value does not represent the full effect of the reduced hours of labor, for in the three weeks after Easter the hourly output was 55 per cent above that of the pre-Christmas period and the total output 38 per cent above it. Such results are so astonishing that one is naturally inclined to doubt their validity, but there appears to be no reason for denying their substantial accuracy. The boys must have been seriously overworked by the long hours, and hence the 8 to 12 hour reduction of the working week accelerated their rate of production much more than did the 6-hour reduction accelerate that of the men "sizers."

TABLE VI.—NINE YOUTHS SIZING BASE PLUGS.

Statistical period.	Average hours of actual work.	Average (relative) hourly output.	Hours multiplied by output.
5 weeks preceding Christmas (Nov. 15-Dec. 19).....	68.3	100	6,830
2 weeks at Christmas (Dec. 20-Jan. 2).....	46.3	106	.....
4 weeks after Christmas (Jan. 3-Jan. 30).....	70.3	116	8,155
11 weeks later (Jan. 31-Apr. 16).....	57.0	142	8,094
2 weeks at Easter (Apr. 17-Apr. 30).....	42.1	135	.....
3 weeks later (May 1-May 21).....	60.9	155	9,440

MEN ENGAGED IN MODERATELY HEAVY LABOR.

18. Typical examples of moderately heavy labor are found in shell making, and all the data described in this section relate to the output of 3-inch shrapnel shells. One of the most important and lengthy of the operations is that known as boring the powder chamber. This operation is performed on capstan lathes provided with three sets of boring tools, and it requires considerably more muscular energy than that involved in turning fuse bodies, though not so much as in sizing. At one shell factory, where the male operatives were being largely replaced by women, I was informed that though the women attained a good output in most operations, they produced only about half as many shells as the men did in this particular operation, since they had not the necessary strength.

19. The data in Table VII concern the output of 23 operatives, all of whom had been 4 months or more at the process previous to the statistical period recorded. During these months they worked at first for 53 hours per week, and subsequently for 49½ hours, and had attained their maximum output for these particular hours of labor. When their hours were suddenly increased to 64 per week (7 hours on Sunday), we see that they maintained their hourly output for three weeks with very little diminution. After this time there was a shortage of material at irregular intervals, so the output data were rendered valueless for statistical purposes, but even if the hourly output had fallen considerably lower, the total output would still have remained higher during a 60-hour week than during a 48-hour week.

TABLE VII.—TWENTY-THREE MEN BORING THE POWDER CHAMBER.

Week ending—	Weekly hours of actual work.	Hours of broken time.	(Relative) hourly output.	Hours multiplied by output.
Nov. 7.....	48.5	{ 1.0 } 1.7	{ 100 } 100	4,780
Nov. 14.....	47.1			
Nov. 21.....	59.5			
Nov. 28.....	60.5			
Dec. 5.....	59.1	{ 3.5 } 3.1	{ 98 } 100	5,970
		{ 1.4 }	{ 94 }	

20. An important operation is to “finish, turn, and form” the shell, which consists in taking off a fine turning, and afterwards filing down the shell. This operation probably needs the expenditure of about as much muscular energy as that of turning fuse bodies. The data in Table VIII show the output of 22 men who had been engaged at this work for 10 weeks, on an average, previously to the statistical period dealt with.

TABLE VIII.—TWENTY-TWO MEN, FINISHING, TURNING, AND FORMING 3-INCH SHELLS.

Week ending—	Weekly hours of actual work.	Nominal hours of work.	Hours of broken time.	(Relative) hourly output.	Hours multiplied by output.
Aug. 29.....	62.0	64	2.0	98	6,080
Sept. 5.....	64.1	65	.9	100	
Sept. 12.....	51.6	52	.4	101	
Sept. 19.....	63.4	64	.6	101	
Sept. 26.....	52.3	53	.7	105	5,905
Oct. 3.....	39.0	39	.0	112	
Oct. 10.....	51.2	52	.8	112	
Oct. 17.....	53.0	53	.0	118	
Oct. 24.....	51.2	53	1.8	112	

21. The hours of labor in the immediately preceding week had been 64, but before that they had been 49 for 3 weeks, preceded by 64 or more for 7 weeks. We see that, on an average, the hourly output during the last 3 weeks recorded in the table, when the hours of labor averaged 51.8 hours, was 14 per cent greater than in the first 4 weeks when they averaged 60.3 hours. It is probable that a portion of this improvement was due to increased skill of the operatives, who were found to require 3 or 4 months' experience before attaining their maximum output, but assuming that the whole of the improvement was the direct result of the reduced hours of labor, the total output is still less for the short-hour weeks than for the long ones. The timekeeping was extremely good and suggests that the operatives could easily stand the 60-hour week, for not only was the broken time 1 hour per week or less, but during the 60-hour period recorded the operatives were never absent for a whole week, and they put in only 4 per cent of short weeks. It should be mentioned that in calculating broken time the 45-hour limit referred to previously was retained for operatives working $58\frac{1}{2}$ hours or more per week, but with operatives working a nominal 52 hours only those were excluded who put in less than 40 hours of actual work, and with operatives working a nominal $49\frac{1}{2}$ hours only those who put in less than 38 hours of actual work.

MEN AND YOUTHS ENGAGED IN LIGHT LABOR.

22. In the operation known as "rough turning," the rough shell is turned approximately to size. During four-fifths of the time required the operative merely watches the lathe, so the labor is very much lighter in type than that previously described and resembles that required for milling a screw thread on fuse bodies. The hourly output of 18 men was investigated and was found to be constant within the limits of chance error, whether they were working 49, 53, or 64 hours per week. For instance, on changing from a $49\frac{1}{2}$ -hour to a 64-hour week, the hourly output during three consecutive weeks was 100, 102, and 101 on that of the preceding weeks taken as

100. Again, when the 20 operatives of a permanent night shift had their hours increased from $47\frac{1}{2}$ to $53\frac{1}{2}$ for one week, and then to 67 hours for two weeks, their output was 99, 97, and 96 in the 3 weeks respectively, that of the preceding weeks being taken as 100. There can be little doubt, therefore, that these operatives could have worked longer weekly hours than 64 or 67 without greatly diminishing their hourly output, and so have attained a greater total output. This conclusion is strongly supported by the data for youths which are now to be recorded.

23. The youths, 15 to 18 years of age, were engaged in boring out the top caps of fuses by means of semiautomatic machines. About four times a minute they unclamped one cap and clamped in another, these two clampings together occupying less than two seconds. For the rest of the time they stood at their machines doing nothing. From the average data recorded in Table IX, which concern the output of 17 operatives, it will be seen that before Christmas they averaged 75.6 hours per week of actual work out of the $78\frac{1}{2}$ nominal hours. In the 6 weeks after Christmas their hourly output went up 6 per cent, but in that they averaged 4.7 hours a week less than before, their total output was slightly diminished. The output of the week February 14-20 is omitted, as there was a shortage of material, but in the next 8 weeks, when the average hours were reduced to 59.4 per week, the output rose another 2 per cent. This rise by no means compensated for the considerable reduction in working hours, so we find that the total weekly output was actually 15 per cent less than in the pre-Christmas period.

TABLE IX.—SEVENTEEN YOUTHS BORING TOP CAPS.

Statistical period.	Average hours of actual work.	Average hours of broken time.	Average (relative) hourly output.	Hours multiplied by output.
5 weeks preceding Christmas (Nov. 15-Dec. 19).....	75.6	2.9	100	7,560
2 weeks at Christmas.....	50.0	2.7	106	.....
6 weeks after Christmas (Jan. 3-Feb. 13).....	70.9	4.6	106	7,515
8 weeks later (Feb. 21-Apr. 16).....	59.4	4.4	108	6,415
2 weeks at Easter (Apr. 17-30).....	40.8	4.6	95	.....

24. It seems probable, therefore, that to attain maximum output 70 hours or more per week of this light labor must be worked. It will be seen from the table that when the operatives were working over 70 hours per week their broken time was not excessive. Moreover, they put in only 2 per cent of short weeks and 3.6 per cent of absent weeks on an average, so the long hours did not appear to affect their health.

COMPARISON OF RESULTS.

25. The various types of labor investigated may conveniently be divided into five, viz, very heavy, heavy, moderately heavy, light, and very light. Of these types the "very heavy," such as sizing fuse bodies, and the "heavy," such as boring the powder chamber, are not well suited to women. On the other hand, the "light" type, such as boring top caps and rough-turning 3-inch shells, had better be confined to women, as it is waste of muscle to appropriate them to men, or even to youths. Very light types of labor such as sedentary gauging operations should evidently be confined to women and girls.

26. We have seen that for men engaged in the very heavy labor of sizing fuse bodies the maximum hours of actual work appeared to be 56 or less per week for men engaged in boring the powder chamber and in turning and finishing shells they were probably 60 or rather more, whilst for men rough-turning shells and for youths boring top caps they were probably 70 or even more. On the other hand, for women engaged in the moderately heavy labor of turning fuse bodies the maximum hours were 56 or less, whilst for women on the light labor of milling a screw thread they were rather over 60 hours. In so far as time keeping is a criterion, women and girls on the very light work of gauging fuses appeared to stand even 76 hours fairly well, but it is more than likely that their actual output was little, if any, greater than when they were working 64 hours, and so it is probable that this figure should be regarded as their maximum.

27. It must be realized that all of these data are provisional, but they clearly justify the conclusion that the hours of labor should be varied between wide limits according to the character of the work performed. This obvious fact is not realized by many managers of munition works, and the tendency is usually toward uniformity of hours for all types of labor and for workers of both sexes. The data adduced suggest that not only are women unsuited to the heavier types of work, but that even when engaged on the moderate and light types they are unable to stand such long hours as the men. Several sets of operatives, both male and female, were kept under close observation for many days in order that their powers of application might be investigated. Men engaged in boring the powder chamber and in turning and finishing shells were found, almost without exception, to stick to their work with admirable persistence, and it was very seldom that they rested even for a minute. On the other hand, women engaged in turning fuse bodies rested for times which in aggregate amounted to $1\frac{1}{2}$ hours out of the 12-hour day, and over an hour out of the 10-hour day, in addi-

tion to the hour or so of compulsory rest required for attention to their lathes at the hands of the tool-setters. About half an hour of the voluntary rest pauses occurred on starting and stopping work, but much of the remaining hour or half hour was probably due, not to idleness on the part of the women, but to fatigue, and to an instinctive knowledge that short rest pauses helped to prevent undue fatigue. Still, it would have been better if these pauses and the times lost in starting and stopping had been curtailed by, e. g., half an hour a day, and the women had been permitted a corresponding reduction in their weekly hours of labor.

28. It is to be borne in mind that all of the times mentioned are the maximum hours of actual work, supposing that a maximum output is required regardless of cost production. They necessarily impose a great strain on the operatives, and there can be no doubt that in many instances the strain was too great to be borne, and that the operatives had to drop out altogether. That is to say, the data quoted relate to the fittest who were strong enough to survive in the struggle, and not to the general mass of workers of all classes who tried their hand at munition work. It is almost impossible to discover the extent of this weeding out, but it is inevitably considerable. Hence the best hours of work, suited for peace times, are in every case considerably shorter than those mentioned, though the principle of graduating the number of hours of labor to the type of work performed still holds with undiminished force.

FURTHER POINTS FOR CONSIDERATION.

29. Though stern necessity may compel long hours of labor on the part of many munition workers, it is evident that, provided maximum output is maintained, the shorter the times for which they are shut up in the factories the better their chances of health and happiness. Hence everything possible should be done to speed up the rate of production so far as this can be done without making an extra call upon the physical energies of the operatives. Though I have no intention on the present occasion of discussing the matter in detail, I wish to suggest two simple plans of appreciably increasing the rate of production. The first depends on greater promptness in starting work. A few concrete instances will bring home the importance of this point, at least in some munition factories. In most works the motive power is electric, and in some the power supplied to each section is registered by a separate wattmeter. The machinery is started running shortly before work begins, and as the operatives get going, one after another, the power consumption steadily rises to a maximum, which is attained when all the operatives have started. By means of these power records the rate of

starting and stopping work can readily be ascertained in many instances, though not in factories where time is spent in preliminary collection of necessary tools and material, and in their adjustment. The accompanying figure [figure not reproduced] records the increments of electric power over that required to drive the free-running machinery, on starting and stopping the afternoon spell of work. The continuous line represents the power supplied to a large shell shop which turned out 30,000 3-inch schrapnel shells per week. We see that the power supplied started mounting up 2 minutes after starting time, and reached half its full value in 4 minutes. The dotted-line curve, representing the power supplied to a section of 200 women turning fuse bodies, did not begin to rise till 5 minutes after starting time, and did not attain half its maximum value until 11 minutes after starting time. In other words, the operatives wasted about 7 minutes more in starting than did the operatives in the shell shop, most of whom were men. On the other hand, the fuse-turners finished more strongly than the shell-shop operatives, as can be seen by comparing the two curves given on the right side of the figure, and it was found that both sets of operatives lost, on an average, about the same aggregate of time in starting and finishing during the course of the whole day, viz, 34 minutes. The shell-shop operatives did not start much more promptly than the fuse turners in the morning, partly because there was more delay in the arrival of their material, but in spite of this, if the operatives of both shops had started equally promptly, and finished equally strongly, 9 minutes out of the 34 would have been saved. There was no inherent reason why work should have been started promptly in one shop and not in the other. It was merely a custom of the particular shop, and even then the custom was not a fixed one. A series of meter readings of the women's section were taken for several days before and after the Easter holiday, and 9 days before the holiday the average amount of time wasted in starting after dinner was found to be 11 minutes; 2 days before it was 14 minutes. Two days after the holiday it was 16 minutes; 3 days after it was 15 minutes; and 5 days after it was 12 minutes. That is to say, it increased with the slackness of the operatives caused by the immediate approach of the holiday, and still more with their post-holiday lassitude.

30. There can be no necessity for the waste even of 25 minutes in starting and finishing work. Ten or 15 minutes should be ample allowance, and the 20 minutes thereby saved could be deducted from working hours without any reduction of output. At one large works the manager informed me that he made a point of going into the various shops at starting time and seeing that the operatives began work promptly. In this way a considerable amount of time was saved.

31. The other method of speeding up production on which I wish to lay stress has already been referred to in an earlier memorandum (No. 7). It consists in the regulation of rest pauses. The custom in many munition works is for the operatives to work for a spell of five hours, and then, after an hour's interval, for another spell of $4\frac{1}{2}$ to 5 hours. Such spells are undoubtedly too long in many types of munition work, but if a second break is introduced in the working day much extra time is lost in starting and stopping work. If the operatives are left to themselves they take rests at irregular and often unsuitable times. Hence it would be much better if the rest pauses were chosen for them. For instance, a 10-minute break in the middle of the morning and afternoon spells, during which the operatives remain at their machines, but take tea or other nutriment brought them by boys or by traveling canteens, has been found a valuable aid to output in some munition works. Some types of work need longer and more frequent rest pauses than others, and the best times can be determined only by experiment. After being fixed they should be made compulsory and rest pauses at other times be checked so far as possible.

Signed on behalf of the committee,

GEORGE NEWMAN, M. D.,
Chairman.

E. H. PELHAM, *Secretary.*

AUGUST, 1916.

INDUSTRIAL FATIGUE AND ITS CAUSES.

[Memorandum No. 7.]

DEFINITION AND CAUSATION OF FATIGUE.

1. Fatigue is the sum of the results of activity which show themselves in a diminished capacity for doing work.

In ordinary language fatigue is generally associated with familiar bodily sensations, and these sensations are often taken to be its measure. It is of vital importance for the proper study of industrial fatigue, however, to recognize not only that bodily sensations are a fallacious guide to the true state of fatigue which may be present, and a wholly inadequate measure of it, but also that fatigue in its true meaning advances progressively, and must be measurable at any stage by a diminished capacity for work, before its signs appear plainly, or at all, in sensation.

2. In the animal body the performance of work depends on the activities of parts which are best considered under three groups—first, the complex nervous mechanisms of the brain and spinal cord, which are concerned in the initiation and distribution of impulses to action; second, the nerves, which conduct the impulses to muscles; and third, the muscles themselves, which by contracting finally perform external work.

Fatigue has been separately studied in all these parts. In its essential features the fatigue of all alike has been found, when it occurs, to depend not upon the simple using up ("exhaustion") of the substances supplying the chemical energy which is liberated during work, but upon the accumulation within the living elements of the products of the chemical changes involved. Fatigue of the animal machine, that is to say, is not to be compared with the failure of fuel as in a steam engine or with the running down of a clock weight, but rather with the clogging of the wheels in some mechanism by dirt.

The chemical products of activity in the nervous and muscular elements are removed by the blood, in part directly by irrigation and in part indirectly through chemical changes in the tissue itself induced by constituents of the blood. Rest after activity is not a passive state, therefore, but is itself an active process, or a series of active processes, leading to a restoration of the normal capacity for work. Time is required for these, and the time taken will be in pro-

portion to the amount of restoration needed. There will be a definite relation accordingly between the degree of any given activity and the time necessary for the completion of the subsequent restoration process. If the activity is repeated too quickly to give time enough for restoration after each action, fatigue will become progressively more intense as the debit balance accumulates, and each repeated act in consequence will be more and more impeded and will become smaller, until further action is impossible.

Of the three groups of organs just mentioned, the nervous system, the nerves, and the muscles, particular chemical and structural characters will decide in each case what time relation must exist between action and the rest needed for complete repair. In the conducting nerve fibers fatigue may be said not to occur; it is unrecognizable probably because of the extreme rapidity with which recovery here follows the very small changes associated with activity. Of the other two groups, the initiating and distributing nervous mechanisms of the brain and spinal cord are more quickly fatigued than the contracting muscles, and the important result follows that in the animal body the impulses to activity springing from the brain can not bring the muscles far toward complete fatigue before their sources are themselves fatigued and impotent. Even beyond that point, when the central nerve cells are inactive, impulses artificially sent, in experiment, along the indefatigable nerve fibers will still fail to produce more than partial fatigue in the muscles, for fatigue advances faster still in certain structures known as the end organs, which connect nerve fiber and muscle; there the impulses become blocked so that the muscle again escapes from further activity.

In the tired man the symptoms of fatigue are referred to the muscles; they ache, or they may appear to "give way under him," but in reality the most severe bodily activity fails to produce any close approach to complete fatigue of the muscles. The fatigue is fatigue of the nervous system, though in sensation its effects may be referred to the muscles themselves. A hunted animal may be driven to intense muscular fatigue, but in this extreme case the blood becomes charged with chemical products of activity, for the elimination of which no opportunity is given, and the muscles, with every other organ of the body, become poisoned. Even in laborious work it is doubtful whether a man by voluntary effort can cause his muscles to approach advanced fatigue. It is well known that a man apparently "run to a standstill" in a race may upon some new excitement run freshly again, under augmented stimulus from the nervous system, initiated there perhaps in part along new paths.

The problems then of industrial fatigue are primarily and almost wholly problems of fatigue in the nervous system and of its direct and indirect effects.

THE RHYTHM OF ACTION AND REST.

3. The necessary time relation between an action and the recovery from it in rest has been mentioned already. For every acting element a given rhythm of activity will allow exact recovery after each act, and will maintain the balance between action and repair throughout a long series. The heart, for instance, in alternating contraction and relaxation, may continue to beat incessantly through the life of a man without any accumulated fatigue for 70 years or more. Among the great variety of nerve centers there will be found a great variety in these time relations. Some may allow a relatively rapid rhythm, as in the act of breathing, where the rhythm, which is a nervous rhythm, may be almost incessant for years, while at the other end of the scale there are slower rhythms like those shown in the need for diurnal sleep.

In connection with this natural pace of the animal machine, to and fro, from action to rest, reference must be made to the wide adaptability of the animal mechanisms, and especially to that of the nervous system, in response to training and use. Complicated coordinations in the nervous system, at first easily fatigued, may by training, and, as it seems, by some improvement in the routes of connection due to the increase of traffic itself, become capable of maximum efficiency at a more rapid rhythm. A man will swing each leg, weighted with a heavy boot, as in walking, for 10,000 times in an unbroken march without notable fatigue, but he can not as an impromptu exercise raise his lightly weighted finger for more than a few score times at no faster rate before the movement comes to complete standstill.

4. The problem of scientific industrial management, dealing as it must with the human machine, is fundamentally a problem in industrial fatigue. The rhythms of industrial conditions, given by the hours of labor, the pace of machinery or that of fellow workers, or otherwise, are imposed upon the acting bodily mechanisms from outside. If these are faster than the natural rhythms, they must give accumulated fatigue, and cause an increasing debit, shown in a diminished capacity for work. It is therefore the problem of scientific management to discover in the interests of output and of the maintained health of the workers what are the "maximal efficiency rhythms" for the various faculties of the human machine. These must be determined by the organized collection of experience or by direct experiment. They must be separately determined, moreover, not only for the performance of relatively simple muscular movements, all of which depend on the action of "lower" nervous centers, but also for the "higher" coordinating centers, and for both of these the natural rhythms must be studied for the best arrange-

ment of short spells, and again for that of the hours of shifts, of the periods of sleep, and, at the last point of the scale, of holidays.

SIGNS AND SYMPTOMS OF FATIGUE.

5. It must be repeated that the subjective sensations of fatigue are not a measure, or even an early sign, of it. Real or objective fatigue is shown and is measurable by the diminished capacity for performing the act that caused it.

6. *Bodily fatigue*.—Fatigue following muscular employment is primarily nervous fatigue, as explained already, and we have seen that no advanced degree of muscular fatigue as such can be obtained by voluntary action, for fatigue in the nervous system outstrips in its onset fatigue in the muscles. In accustomed actions, however, as in walking or digging, where there has been habituation, the activity may be so prolonged without great nervous fatigue as to give approaching “exhaustion”—that is, notable loss of chemical substance—in the muscles. Industrial work is habitual work, but the case in which muscular labor is so intense and prolonged as to give exhaustion in this sense need not be considered here, nor the causation of the special symptoms which arise. It must be noted, however, that practically the whole of the mechanical energy and heat yielded by the body during work comes from the chemical energy stored in the muscles. In proportion as this store is called upon, and quite apart from the question of fatigue, it must be made good by supplies from the blood and ultimately from the food. Practically the whole of the energy transformed in the muscles is derived from carbohydrate material, and the importance of this in relation to the diet of workers is discussed in Memorandum No. 3.¹

For work in which severe muscular effort is required it seems probable that the maximum output over the day's work and the best conditions for the workers' comfort and maintained health will be secured by giving short spells of strenuous activity broken by longer spells of rest, the time ratio of rest to action being here, for maximal efficiency, greater than that for the employments in which nervous activity is more prominent or more complicated than in the processes involved during familiar muscular work.² This difference may be connected directly with the greater bulk of chemical material which must be mobilized when, as in severe muscular exercise, so large a

¹ Reprinted in Bulletin No. 222.

² This point is one of incessant practical interest in many industries, and it may be noted that it has an immediate bearing upon the routine proper for rapid trench digging. Two officers at the front recently, for a friendly wager, competed in making equal lengths of a certain trench, each with an equal squad of men. One let his men work as they pleased, but as hard as possible. The other divided his men into three sets, to work in rotation, each set digging their hardest for 5 minutes and then resting for 10, till their spell of labor came again. The latter team won easily. The problem here gives another obvious opening for scientific organization based on the results of experiment.

proportion of the whole body mass is engaged in the chemical events involved in movement and doing work; but further scientific study is needed here.

7. *Nervous and mental fatigue.*—It is under this head, as we have seen, that the special problems of industrial fatigue arise. The signs and symptoms of the fatigue will depend upon the nature of the particular work done, whether it be general bodily work of this or that kind, carried out in fixed routine, or whether it involve mental activity of a simple or of a more complicated kind. The fatigue may spring from the maintained use of intelligence and observation with varying degrees of the muscular effort necessary in every kind of work, or from the maintenance of steady attention upon one skilled task, or of distributed attention, as when several machines are to be tended or other manipulations performed; or, again, it may depend upon the continued use of special senses and sense organs in discrimination, whether by touch or sight. It will be affected greatly according to whether the worker has opportunity for obeying his natural rhythms, or whether unnatural rhythm is imposed upon him by the pace of the machine with which he works or by that of his fellow workmen. Considerations so inexplicable at present in terms of physiology as to be called “psychological” will also arise; if the work is of a “worrying” or “fussy” kind, with a multiplicity, that is to say, of imposed and irregular rhythms, fatigue will be more rapid, perhaps on account of the more numerous and “higher” nervous centers which become implicated.

Monotonous work—and much industrial work is monotonous—offers some special problems. It has been seen that uniformly repeated acts tend to become in a sense “automatic,” and that the nerve centers concerned become less liable to fatigue—the time ratio of necessary rest to action is diminished. But when monotonous series are repeated, fatigue may appear in what may be called the psychical field, and a sense of “monotony” may diminish the capacity for work. This is analogous to, if it does not represent, a fatigue process in unrecognized nervous centers. Conversely, “interest” may improve the working capacity even for a uniform monotonous activity, and the interest may spring from emotional states, or, as some think, from states of anticipatory pleasure before mealtime and rest (“end spurt”), or again, from a sense of patriotism eager to forward the munitions output.

It may be remarked that mental processes, like those involved, for instance, in adding up figures, may be maintained for very long periods—subject to the needs of change of posture and of diurnal sleep—with no great loss of capacity, that is, without marked fatigue in that particular process. Such diminution of capacity as occurs, and the sense of fatigue that is felt subjectively by common expe-

rience in such a task, appear to be due to "monotony," and to be removable by means of "interest."

8. For practical purposes in industrial management two chief characters of nervous fatigue must be observed. First, during the continued performance of work the objective results of nervous fatigue precede in their onset the subjective symptoms of fatigue. Without obvious sign and without his knowing it himself, a man's capacity for work may diminish owing to his unrecognized fatigue. His time beyond a certain point then begins to be uneconomically spent, and it is for scientific management to determine this point, and to determine further the arrangement of periods of rest in relation to spells of work that will give the best development over the day and the year of the worker's capacity. Second, the results of fatigue which advances beyond physiological limits ("overstrain") not only reduce capacity at the moment, but do damage of a more permanent kind which will affect capacity for periods far beyond the next normal period of rest. It will plainly be uneconomical to allow this damage to be done.

For these reasons, chief among others, it will be important to detect latent fatigue, and since sensations of fatigue are unpunctual and untrustworthy, means must be sought of observing the onset of fatigue objectively.

TESTS OF INDUSTRIAL FATIGUE.

(a) OUTPUT.

9. The true sign of fatigue is diminished capacity, and it follows from what has been said that measurement of output in work will give the most direct test of fatigue.

The output must be measured under the ordinary conditions of the work, and, in cases where from the nature of the work the output is not automatically measured, it must be tested by methods which do not allow the workers to be conscious at particular times of the test being made. In this way the errors due to special effort from interest or emulation will be eliminated. The results of work expressed in output must be corrected by allowance for all variable factors save that of the workers' changing capacity; changes in supply of steam or electric power and of raw material, for instance, must be determined for the correction and interpretation of the actual output returns. The output must be estimated for successive short periods (e. g., each hour) of the day's work, so that the phenomena of "beginning spurt" and "end spurt" and other variations complicating the course of fatigue as such, may be traced and taken into account. Isolated tests of output taken sporadically will be meaningless. The records must also extend over longer periods to show the onset of

fatigue over the whole day and over the whole week, and under particular seasonal or other conditions, in order to detect and measure the results of accumulating fatigue.

10. Measurements of output must obviously be recorded at so much for each individual or for each unit group. The size of total output will be meaningless, of course, without reference to the numbers engaged. But it will also be important for proper management to take account of the output of particular individuals. This in many factory processes is easily possible, and when it has been done the results have shown surprising variations of individual output which are independent of personal willingness and industry and have generally been quite unsuspected by the workers and their supervisors before the test was made. Information so gained is valuable in two respects. Good individual output is often the result of escape from fatigue by conscious or unconscious adoption of particular habits of manipulation or of rhythm. Its discovery allows the propagation of good method among the other workers. In the second place, these tests of individual capacity (or its loss by fatigue) give an opportunity for a rearrangement of workers and their assignment to particular processes of work. Astonishing results, bringing advantage both to employers and employed, have been gained in other countries by the careful selection of individuals for particular tasks, based not upon the impressions of foremen but upon the results of experiment.¹

11. If the proper adaptation to particular kinds of labor of the relations of spells or shifts of work to rest intervals and to holidays is to be determined, as it can alone be, by appeal to experiment, it will, of course, be an essential condition for success that the workers should cooperate with the employing management and give their highest voluntary efforts toward the maximum output during the spells of work. It is not surprising that where employers, following tradition rather than experiment, have disobeyed physiological law in the supposed interests of gain—and for a century this has been almost universal—the workers have themselves fallen very commonly into a tradition of working below their best during their spells of labor. In so far as hours of work in excess of those suitable for maximal efficiency have been imposed during the last two or three generations of modern industry upon the workers a tradition of slowed labor

¹ In certain special directions, and with special regard to munition work, the committee are causing some experimental observations to be made for their guidance. The services of Mr. Sargant Florence, working on behalf of the Medical Research Committee (National Health Insurance), have been placed at the disposal of this committee, and he is engaged in studying particular features of output under special conditions of labor at particular factories. In this work he has enjoyed the cordial cooperation of the manufacturing firms concerned, and to these the committee would offer their grateful acknowledgments. The committee propose later to make appropriate use of the results of these investigations.

must necessarily have arisen, probably in large part automatically, as a kind of physiological self-protection. Without some conscious or unconscious slackening of effort indeed during working hours of improper length in the past, the output might have been even more unfavorable than we know it to have been for the hours of work consumed.

It has happened, moreover, that, rightly or wrongly, a suspicion has grown up among workers that any device for increasing output will be used for the profit of the employer rather than for the increased health and comfort of the workers. It would be out of place here to touch on the economic and social problems which arise in this connection, but until such solutions are found for them as will bring a hearty cooperation between employers and employed, in the task of finding the optimum condition of work for the benefit of both, there will be no certain prospect of determining the true physiological methods for getting the best results in modern industrial occupations.

The committee believe that in the present time of crisis patriotic incentive has done much to abolish customary reduction of effort among munition workers, but it is of great importance to note that a special and strenuous voluntary effort in labor, if it be maintained under a badly arranged time-table of work and rest, does not necessarily bring increased output over a long period, however praiseworthy the intention of effort may be. Under wrong conditions of work, with excessive overtime, it is to be expected indeed that some deliberate "slacking" of the workers might actually give an improvement of output over a period of some length by sparing wasteful fatigue, just as the "nursing" of a boat crew over part of a long course may improve their performance. It can not in such circumstances be said that a workman so restraining himself, consciously or unconsciously, is doing more to damage the output on the whole than the employer who has arranged over-long hours of work on the baseless assumption that long hours mean high output.¹

In a specific instance before the committee, a group of five male voluntary Sunday workers in a certain munitions factory were able in 8 hours (or 7 hours free of meals) to exceed the average days' output of eight week-day men, who work 14 hours (or 12½ hours free of meals). These five men worked, no doubt, at a "sprint," which could not perhaps have been maintained daily. But there

¹ It is said that women workers now engaged upon munitions have no customary usages of sparing themselves, and that the weekly output per woman often exceeds that per man. The experienced manager of a large shell factory employing 1,200 men and 1,500 women expressed his confidence that the three 8-hour shift system gives better output and maintains better health than that of two 12-hour shifts. He is "satisfied that there is a period of slacking, often quite unconscious, during a 12-hour shift which is detrimental to output." Investigation elsewhere suggests, however, that the output for the long shift might be even worse without this unconscious restraint.

can be little doubt that they could repeat their eight hours' effort on, say, four days in a week; and, if so, the startling result follows that they could do in those four days rather more than the whole week's work of an equal set of men adopting the other system of hours. With this, moreover, they could enjoy not only longer nights and more recreation time in each working-day, but could also have three whole holidays in the week. Would these five volunteers be "slackers" if they did a full week's work judged by the 14-hour standard, or more, but had three holidays a week (available perhaps for a change of work) and slept longer at night? It is impossible to resist the conclusion that the paid week-day workers at this factory, who have been working their long hours for many months, might have greatly improved both their output and their comfort under a better chosen system of special efforts alternating with suitable rests. The work in question was work of a uniform "repetitive" kind, involving moderate physical exertion.

At another large factory the manager is considering closely the problems raised here. He is proposing to aim at "sprint," and hopes to get the same output from $7\frac{1}{2}$ hours' work as from the present $10\frac{1}{2}$ hours' work. He instituted a competition as to which shift and which group of men could do most as an experiment. He found that a small bonus "increased the output of a group of boys 120 per cent."

At one long-established factory a new shop has been built and staffed so as to produce 5,000 of a particular stock article of warfare per week, that estimate being based upon the results of the older shops doing the same work. New hands were engaged, and these in the new shop are now, after six months, producing in spite of their inexperience not only 5,000, as expected, but 13,000 of these articles per week. The older hands in the other shops do not approach this output, though all the mechanical conditions of work are practically equal. As patriotic interest in their output appears to be shared here by all the men alike, the lower output by the more experienced hands appears to be assignable only to the effects of long-standing customary restrictions upon habits or rhythm of work from which the newer hands are free.

In addition to the direct measurement of output certain secondary symptoms of fatigue may be studied usefully as its index.

(b) ACCIDENTS AND SPOILED WORK.

12. An important and early sign of fatigue in the nervous centers is a want of coordination and failure in the power of concentration. This may not be subjectively realized but may be shown objectively in an increased frequency of trifling accidents. The accidents are due to momentary loss of attention and may result in personal damage to the worker, trifling or serious, breakages of tools or materials, or the spoiling of work. In well-managed factories the incidence of accidents of this kind is recorded for unit periods throughout the day, and these records may provide a good secondary index to fatigue, but only in so far as they are corrected by reference to the rate of work being done and other variables. Results of the use of this method by Mr. Sargant Florence have recently been published in the report made to the British Association at Manchester in last September, but at present these results lack the necessary parallel determinations of rate of output and other factors for their correction.

(c) ASSOCIATED FATIGUE AND LABORATORY TESTS.

The primary sign of fatigue in a given function is diminished capacity. But there is evidence to show that accumulated fatigue in connection with a given act may affect adversely the condition of other parts of the nervous system not immediately employed. There is little experimental knowledge, however, as to whether this effect, shown in associated fatigue, is more direct and definite in kind than the effect upon general health to be mentioned below. The appearance of associated fatigue will need for its detection and study the application of special tests, involving the use of suitable apparatus and laboratory accommodation. The committee are causing some observations of this kind to be made, and the results of these will be the subject of a later report if it appears desirable.

It should be remembered, however, that experiments of this kind will have no validity unless the fallacies due to emotions and ideas, such as a sense of novelty, interest in the desired result, anticipation of release from experiment, unconscious suggestion by the observer, and so on, are eliminated by the most rigid attention to experimental conditions and by long series of control observations. The objects of experimentation must be trained for the purpose, and it is unlikely that tests of this kind will offer results of sufficient value to justify the special education of teams of selected workers for the prolonged studies which the method demands.

Prof. Stanley Kent has communicated recently to the Home Office¹ the results of some preliminary experiments in this connection. He has inquired whether fatigue due to industrial work shows its effects in associated changes of nervous functions not directly employed in it, as, for instance, in diminishing the quickness of response to signals, in blunting the acuity of hearing, or the acuity of vision, or in lowering other nervous functions. His general findings are sufficient to show that these indirect associated results of fatigue provide no regular and trustworthy index of the primary fatigue. They give indications, but irregularly in some cases and not at all in others, that the general "tone" of the nervous system is depreciated after a day's work, and declines also during a week's work.

(d) SICKNESS, LOST TIME, AND "STALENESS."

13. The accumulated results of fatigue are damaging to general health, and they will be reflected in the sickness returns and in the returns of lost time. Many problems arise here which can not be discussed in detail,² and they are complicated by the influence of other factors, which will be discussed in the following section. Without

¹ Interim report on an investigation of industrial fatigue by physiological methods (Cd. 8056). Price 4½d. (9 cents).

² Further reference is made to this subject in the committee memorandum on sickness and injury.

complete analysis of other variables, sickness returns will be only an indirect guide in the study of fatigue as such.

14. Reference must be made here, however, to a pronounced and common symptom of industrial fatigue, which appears to be the reflection in the workman's general health and "spirits" of the results of accumulated nervous fatigue rather than a direct or measurable sign of it. At the present time in very many munition factories the complaint is made by workers, and not least by the most intelligent and willing of them, that they are feeling "done up," or "fair whacked," to use local phrases, and the evidence shows that this state of "staleness" is becoming increasingly common and obvious. By experienced managers and medical officers this condition of staleness is attributed almost wholly to persistent long hours and the deprivation of weekly rest. It has grave accompaniments, which paradoxically appear not only in a state of lethargy and indifference, but also in a craving for change and excitement. No doubt the restlessness of the condition must often predispose also to indulgence in the alleviations given by alcohol. At all points the state is apt to set up a vicious circle in which the very need for change and rest prevents the proper use of such chances of rest as are given.

The following is typical of many reports made to the committee :

The works manager who showed me round had worked 361 days out of 365, and looked worn. He would welcome Sunday holidays. A skilled toolmaker had had eight days' holidays—including one for a funeral—since the war began (14 months). He complained of the strain on his nerves.

The officials of a very large trade-union said that overtime was generally considered to be excessive. The most skilled workmen were becoming nervy.

Proper attention earlier in the war to the need for weekly rest would have prevented a large part of the diminished capacity of this kind that has been allowed to appear and would have averted much costly and wasteful expenditure upon imperfect work. But stress must be laid here on a further point. For the avoidance of staleness in conditions of strenuous labor it is not enough to treat workmen in the bulk and to regulate daily and weekly rests upon a physiological basis devised for the average. If that be done, widespread evils like those too commonly present now may be avoided, but good management will consider always the individual workman as well. The committee have no doubt that in very many cases—perhaps in almost all—in which staleness is well marked or has even advanced to definite sickness, a single "day off," given occasionally at the right time, would have avoided much wasteful reduction of capacity and in the worst cases the total loss of many days of work.

THE STUDY OF INDUSTRIAL FATIGUE.

15. By studies of industrial fatigue measured by tests of individual output a large body of valuable information has already been gained in various countries, and its application wherever management is scientific has become a commonplace of administration.¹ It must be admitted, however, that in England—and, no doubt, to the detriment of both health and wealth—management based upon the experimental science of industrial fatigue is far less common than in the factories and business concerns of America and of Germany. The committee, in their memorandum (No. 5) upon hours of work, paragraph 7, have already pointed to the surprising uncertainty commonly found in this country, even where professional knowledge is to be expected, with regard to the proper solution of some of the most elementary practical problems of labor management.

16. In the rapid enlargement and organization of munition factories in this country there has been, and is, the most urgent need for the application of the results of experience scientifically acquired. Upon a sudden national emergency the accumulation of fatigue and its results in workers might well be temporarily disregarded, but now, though the special need persists, the race is to be a long one, and a failure to conserve the maximum efficiency of the workers must be disadvantageous. Misguided efforts to stimulate workers to feverish activity in the supposed interests of the country are likely to be as damaging to the desired result as the cheers of partisans would be if they encouraged a long-distance runner to a futile sprint early in his race.

Even during the urgent claims of a war the problem must always be to obtain the maximum output from the individual worker which is compatible with the maintenance of his health. In war time the workmen will be willing, as they are showing in so many directions, to forego comfort and to work nearer the margin of accumulating fatigue than in time of peace, but the country can not afford the extravagance of paying for work done during incapacity from fatigue just because so many hours are spent upon it² or the further extravagance of urging armies of workmen toward relative incapacity by neglect of physiological law.

The committee have found many isolated instances in which the onset of industrial fatigue has been avoided by intelligent observa-

¹ References to published work may be found conveniently in *Fatigue and Efficiency*, by Josephine Goldmark, New York, 1913 (3d ed.), and in the interim report to the British Association (Manchester, 1915) by the committee upon the question of fatigue from the economic standpoint.

² On the question of Sunday work by exhausted men, one foreman said he did not believe in "a holiday on double pay." Another remarked that Sunday work gave "six days' output for seven days' work on eight days' pay."

tion of the output and of the returns of sickness and of lost time, and by prompt initiative in adapting the hours of work to physiological need; but these instances are exceptional. Taking the country as a whole, the committee are bound to record their impression that the munition workers in general have been allowed to reach a state of reduced efficiency and lowered health which might have been avoided without reduction of output by attention to the details of daily and weekly rests. The signs of fatigue are even more noticeable in the case of the managers and foremen, and their practical results are probably more serious than in the case of the workmen.

Examples may be given of the value of intelligent management:

At a large shell-making factory the men for the early months of war worked seven 12-hour day and seven 12-hour night shifts in the week. More recently Sunday work has been stopped (or at least every man has a weekly day of rest), and the men work from 6 a. m. to 7.30 p. m., with half an hour for breakfast and an hour for dinner, tea being brought to the men by the boys while the machinery is running. These hours are long, but, as a result of improvements in organization, they now produce an increased number of shells from half the number of workers. The manager here "attaches the greatest importance to the week-end rests."

At another large munitions factory men engaged in the heavy work of molding are required by the management to rest 15 minutes in every hour of work. The manager was satisfied that this was an arrangement good for the men and for the output. But the men objected to this long spell of rest in each hour because the work was piecework, and they thought the production would be lessened by it. The manager accordingly found it necessary to set a foreman to watch and to make the hourly rest compulsory. When this was done the output per hour was found to be actually increased.

At another munitions factory the committee learned that the manager had given a break of 15 minutes daily at 11 a. m. to girls engaged in sedentary work of a monotonous repetitive kind. During the break the girls had recreation in the open air. In spite of this deduction from their working hours of the time so spent, the output per day was increased.

17. The problems of industrial fatigue, already soluble in part by reference to an available body of knowledge well known and used in other countries, have become acute during the great recent development of the munitions industries of Great Britain. It is not too much perhaps to hope that the study of industrial fatigue and the science of management based upon it, which is now being forced into notice by immediate need, may leave lasting results to benefit the industries of the country during succeeding years of peace.

Our national experience in modern industry is longer than that of any other people. It has shown clearly enough that false ideas of economic gain, blind to physiological law, must lead, as they led through the nineteenth century, to vast national loss and suffering.

It is certain that unless our industrial life is to be guided in the future by the application of physiological science to the details of its management, it can not hope to maintain its position hereafter among some of its foreign rivals, who already in that respect have gained a present advantage.

Signed on behalf of the committee,

GEORGE NEWMAN, M. D.,
Chairman.

E. H. PELHAM, *Secretary.*

JANUARY, 1916.

NOTE.

Several other important studies of industrial fatigue were published during 1915 and 1916 in Great Britain, and it is understood that the results of all of these studies were available to the committee and that its own report on industrial fatigue may be regarded as a summing up of these various studies of fatigue and its own studies of hours of labor. The studies referred to are the following:

- "Interim Report on an Investigation of Industrial Fatigue by Physiological Methods"; by A. F. Stanley Kent, M. A., D. Sc., Professor of Physiology in the University of Bristol. Great Britain, Home Office, London, 1915. 34 pp.
- "Second Interim Report on an Investigation of Industrial Fatigue by Physiological Methods"; by A. F. Stanley Kent, M. A., D. Sc., Professor of Physiology in the University of Bristol. Great Britain, Home Office, London, 1916. 76 pp., 18 charts.
- "The Question of Fatigue from the Economic Standpoint." Interim Report of the Committee, British Association for the Advancement of Science. Manchester, 1915. 67 pp.
- "The Question of Fatigue from the Economic Standpoint." Second Interim Report of the Committee, British Association for the Advancement of Science. Newcastle, 1916. 24 pp.

These various reports were summarized in an article entitled, "Some New Studies of Industrial Fatigue," in the December, 1916, issue of the Monthly Review of the United States Bureau of Labor Statistics, page 97.

SICKNESS AND INJURY.

[Memorandum No. 10.]

INTRODUCTION.

1. The effect of industrial occupation upon the health of the worker has been a subject of medical investigation since the seventeenth century. Early in the nineteenth century similar inquiries were instituted in England, and in 1831 Thackrah showed that the environment and conditions of factory life, or the mental and physical strain entailed, were associated with exceptional disablement, disease, or mortality among the persons employed. Numerous commissions have been appointed by the Government to ascertain more precisely the exact causes of such effects, and these have considered successively the general circumstances of the worker, the injurious influences of the factory system, the special conditions of certain occupations, the risks incurred in the use of machinery, and the results arising among those employed in dangerous trades. Thus has been accumulated a vast body of medical experience, growing with the growth of industry and with the increase of our knowledge of the causes of disease. Concurrently with the appearance of evidence of a medical and social character further light has been thrown upon the subject by actuaries, insurance agents, and statisticians. As long ago as 1853, Finlaison, the actuary of the national debt, said that "the real practical difference in the distribution of sickness seems to turn upon the amount of expenditure of physical force," and 50 years later, in 1903, Watson, who had studied the subject from an actuarial point of view, wrote that "the proportion of members sick during any year varies with occupation." Again, the experience of insurance authorities confirms the same view. The report on national health insurance for 1913-14 states that "in many cases the rate of sickness is affected by occupations or by the conditions incidental to particular occupations." Lastly, there is the incontrovertible evidence furnished by the bills of mortality steadily accumulating in proof as the years pass. The decennial reports of the registrar general demonstrate that certain occupations have a high comparative mortality, that this mortality is due to well-defined and preventable diseases, that the occupation may exert a greater influence on mortality than the aggregation of population and its associated conditions, and that occupational mortality is affected by the age incidence of the worker.

SICKNESS AND ITS CAUSES.

2. Sickness due, directly or indirectly, to industrial occupation takes various forms and degrees, from a passing headache to serious organic disease of fatal issue. The lungs, the heart, the digestive organs, the nervous system, the muscular system—each or all may be affected, with results harmful both to industrial efficiency and output and to personal health and expectation of life. Moreover, it must be remembered that an undue proportion of sickness in any group of workers usually represents among those not actually sick, lessened vigor and activity, which can not fail to reduce output. Disabling conditions or influences which injure some have a tendency to mark all. It is desirable that employers and their workpeople should have a general appreciation of these injurious conditions in order to be on the outlook to guard against them or mitigate their evil effect. Speaking generally, attention should be given to the following points:

- (1) Excessively long hours of work, particularly by night, if continued, produce fatigue, irritation, and sickness. "You will find," wrote Sir James Paget, "that fatigue has a larger share in the promotion or permission of disease than any other single casual condition you can name." (See Memorandum No. 7 on "Industrial fatigue and its causes.")
- (2) Cramped and constrained attitudes or postures during work, which prevent the healthy action of lungs and heart.
- (3) Prolonged or excessive muscular strain—e. g., the lifting of heavy weights, prolonged standing—may produce rupture or varicose veins.
- (4) Machinery accidents. (See below.)
- (5) Working in unventilated or insufficiently ventilated workshops predisposes to disease and gravely interferes with individual energy and physical capacity. The effect of continuously working in a stagnant or polluted atmosphere is not trifling or insignificant.
- (6) The air, even if fresh, may be too hot or too cold, too humid or too dry; either extreme should be avoided to insure reasonable bodily comfort and the most efficient work.
- (7) Imperfect lighting, whether by day or night, conduces to eyestrain and headaches.
- (8) Working with or in the presence of gases, vapors, poisons, and irritating substances (e. g., "doping") may lead to direct poisoning.

- (9) Dust produced in certain industries, unless effectually safeguarded, may induce lung diseases.
- (10) The manufacture and use of high explosives involve risk to the workman.

While this seems to be a sufficiently formidable list of disabling conditions, or conditions which without proper care and precaution may readily become disabling, it does not complete the inventory. At least as important as any of these occupational influences, but inseparable from them, is the predisposition to disease arising from an absence of personal hygiene. The necessities of individual health are few and simple, but they are essential. Suitable and sufficient food, fresh air, warmth, moderation, and cleanliness in the ways and habits of life, the appropriate interrelation of work, repose, and recreation of mind and body—these are the laws of hygiene, the elements of vital importance, for which facilities must be provided if the maximum industrial output of the individual is to be secured and maintained. Hence arises the necessity for the management to consider these matters for the workpeople in their charge, in addition to the health supervision of the external circumstances of the factory and its technical processes.

INDICATIONS OF SICKNESS.

3. *The indications of sickness* in a factory fall into four groups of facts, which come before the management. First, there is absence, broken time, irregular timekeeping, or diminished output of the individual worker. Every case of lost time or absence calls for inquiry. It should be properly recorded. A study of such records is certain to disclose the existence of adverse influences or circumstances, to-day unsuspected, which may denote the beginning of sickness. Secondly, there are the ordinary signs of ill health, the listless or jaded worker, lassitude, headache, faintness, cough, vomiting, etc. Thirdly, there is the sickness register which should be kept in all well-organized factories. The keeping and examination of this register should be the duty of a duly authorized officer, possibly a trained nurse or welfare supervisor. Medical certificates should be required, correctly recorded and carefully examined. Week by week the management should scrutinize their chart of sickness returns and study their rise and fall. Only thus can they keep themselves informed on this vital matter. Lastly, there are the death certificates, few in number, but extremely important as indications of the health of the workers as a whole. In the past, when the supply of labor was plentiful, the necessity for a study of the influences which affect human efficiency may have escaped recognition, but to-day, when skilled labor is scarce, the neces-

sity is obvious. To conserve energy and efficiency is *cœteris paribus* the way to improve output.

4. The subject of the sickness rate is perhaps the most important of these four signs of a significant amount of ill health among employees, and it may be well to give an example in illustration thereof. A well-known and typical munition works had some 14,000 employees in July, 1914. After the outbreak of war the number rapidly increased; by the end of the year it had doubled, and in March, 1915, the number employed was upwards of 36,000. The percentage of sickness in July was 2.9; in December it was 2.4; and in the first quarter of 1915 it exceeded 4 per cent, to some extent probably owing to seasonal causes. During the same period the accident rate also showed some increase. A recent inquiry showed that in two departments the sickness rate among men on overtime was 5.5 as against 3.7 among those on double shifts. In one of these departments among a body of nearly 1,000 men working overtime the sickness rate reached 8 per cent, the leading causes being probably the greater age of the workers, a 15-hour day, frequent Sunday work, and the special strain of the work. The medical officer of the works attributed the increase of sickness and injury in the factory as a whole to (*a*) a large increase of employees (many new hands), (*b*) overtime, with its attendant fatigue, and (*c*) night work. The principal forms which the sickness took in order of importance were medically reported as influenza, digestive diseases, bronchitis and bronchial catarrh, nasopharyngeal catarrh, rheumatism, nervous diseases and neuralgia, tonsillitis, myalgia, and skin diseases. In another large works the sickness rate had risen to 4 per cent and was still rising, and at a third it was 7 per cent.

METHODS OF REMEDY AND TREATMENT.

5. At the foundation of any sound system of dealing with industrial disease lie two elementary principles, viz, that prevention is better than cure, and that for treatment to be most effective it must deal with the beginnings of disease. Bearing this in mind the preliminary safeguard is to provide for the medical examination of all workers on their admission to the factory in order to secure as far as may be their initial physical fitness for employment. In some munition works this preliminary medical examination is the usual practice and has been found of the greatest advantage, and in special departments, danger zones, etc., there is a periodical medical inspection. Such a procedure forms a convenient opportunity for the inculcation of sound doctrine as to the extreme importance of personal hygiene, cleanliness, and healthy habits. Having thus made sure that the individual worker begins well, the management has two

further duties in the matter. First, they must reduce to a minimum any unfavorable conditions obtaining in their works—providing proper sanitary conditions and accommodations, safeguarding machinery, controlling hours of labor, furnishing canteen facilities, and securing sufficiently warmed, lighted, and ventilated workrooms; secondly, they must make arrangements for an adequate medical and nursing scheme. Medical attendance is obtainable under the national insurance system or may be made available by special provision of a medical and hospital service for the factory; but nursing can only be obtained by the appointment of one or more trained nurses to undertake duties in the factory for both day and night shifts. Such arrangements have been instituted in many munition works, particularly where women are employed and have proved of great value to employers and workers alike. The duties of a factory nurse may include (*a*) supervision of the health of the workers, (*b*) superintendence of the rest room for those who are temporarily indisposed, (*c*) following up cases of sickness at home, (*d*) taking charge of first-aid treatment of injuries, and (*e*) in the absence of medical advice observing and controlling in its initial stages any threatened outbreak of the influenza type of sickness, which, if it extends, may temporarily paralyze output. Wherever nurses have been appointed the committee have found that the scope of their services has extended in many useful directions and they have no hesitation in recommending such appointments.

INJURY.

6. It is a matter of common knowledge that a large number of accidents of great or less severity occur in factories, and particularly in the nontextile trades, metal, engineering, and shipbuilding works. In 1913 178,161 accidents were reported in factories and workshops in the United Kingdom. Moreover, only accidents of a certain degree of severity are reported. A somewhat formidable return of accidents must therefore be anticipated in munition factories, which include not only metal and engineering work but certain dangerous trades and the manufacture of explosives. Moreover, at the present time, the introduction of new labor, and of employees unaccustomed to the processes concerned, particularly in conjunction with the need for speed and pressure, overtime, and night work with the consequent fatigue, must inevitably lead to greater risk of accident. In view of these facts, the committee have not been surprised to learn of the occurrence of many injuries among munition workers. The injuries in a typical munition works are not only open wounds, contusions, and abrasions, injuries to the eye, sprains, simple and compound fracture, and injured limbs, but also scratches, cuts, burns,

and other minor injuries which may readily lead to more serious conditions by neglect. The slightest wound may become infected with germs, and a greater or less degree of sepsis or blood poisoning supervene, with a resultant serious loss of time and efficiency, and possibly even risk to life and limb. The committee have therefore had to consider the prompt treatment of minor injuries, as well as the prevention or treatment of more serious conditions. It is obvious that much can be done by adopting various methods of prevention, such as the proper and effective guarding of machinery, the adoption of safety appliances, the proper regulation of dangerous processes, the adequate lighting of the factory, and the more careful cleaning of machinery. But whatever means be adopted the avoidance of accidents must largely depend on the intelligent cooperation of operatives and foremen in the maintenance and use of the appliances provided, and the committee would be glad to see an extension of the practice of forming committees of workers intrusted with the duty of investigating every accident which occurs in their own work place. In spite, however, of the most perfect regulations and precautions accidents will happen, and the committee desire, whilst drawing attention to the importance of prevention, to emphasize also the pressing need for the provision of suitable means of treatment, and particularly of what may be thought of as first aid treatment for minor injuries, which, by reason of their number, cause perhaps even more interruption to work than those of a more serious character.

7. Much has been accomplished in spreading knowledge of first-aid practice by the St. John Ambulance Association and similar organizations, and in many munition works there are employees who have had some such training. The committee fully recognize that in recent years there has been a marked advance in the provision made by the more enlightened employers for the treatment of injuries in factories. The day is past for condoning slovenly or inadequate provision, and they are satisfied that not only should advice and instruction be given to the worker as to the proper steps to be taken on the occurrence of accidental injuries, but that suitable arrangements should be made in all munition factories for the effective organization of means of emergency treatment.

INSTRUCTION OF THE WORKER.

8. The three methods of advising and instructing the employee, which commend themselves to the committee, are (a) intelligent and vigilant supervision by the foreman; (b) a training in the essentials of first aid of a sufficient number of workers to provide that in each shop there are at least one or two persons who know how to render first aid in cases of injury; such instruction may well include some lessons on the value of ventilation and the importance of using the

means provided to secure it; unfortunately, long hours of work and the difficulty of obtaining competent teachers make training difficult to organize at present, and more use must therefore be made of method (a); and also of (c), the distribution of leaflets or placards of instruction and advice. Any instructions issued should be simple and precise. The placards should be prominently displayed and a supply of leaflets kept readily available for distribution.¹

ORGANIZATION OF TREATMENT.

9. In the majority of factories some provision is made for the treatment of injuries, but inspection has indicated that there is great and urgent need of improvement, especially for treating minor injuries, which must always be numerous in munition factories. At one factory a well-equipped surgery, with a trained nurse in charge, may be found; at the next the surgical equipment is represented by a soiled roll of some so-called "antiseptic" lint or gauze, an open packet of absorbent wool, a few bandages, some antiseptic lotion, a bottle of carron oil, and an unclean pair of scissors, all kept in a dusty drawer. This is not sufficient and can not be approved.

What is required is an adequate though simple organization which provides (a) a local dressing station or aid post in each work place for minor injuries, and (b) a central dressing station or surgery for more serious cases or cases requiring continuous treatment. Any organization should make provision for an aid post in every work place for primary and emergency first aid, the several aid posts being kept in close touch with the central dressing station. Arrangements should also be made for the immediate conveyance to hospital of cases which can not be treated on the spot.

(a) LOCAL DRESSING STATION OR AID POST.

10. In order to be effective under industrial conditions any form of treatment for minor injuries must be extremely simple, easily understood, and readily applicable. Elaborate provision for the treatment of minor injuries is the less necessary because of its unsuitability under factory conditions, and because in machine shops wounds are usually comparatively free from germs. Further, the treatment must be always and promptly available. The workman who sustains a slight injury while at work will often decline to surrender a quarter of an hour of time and earnings in going to and from a central surgery to have his wound dressed. Time is a consideration, and the exigencies of factory life do not allow of an elaborate procedure. The aid post may take the form of a cupboard or box containing first-aid materials, with brief, simple, and clear

¹ A leaflet issued by the Home Office is printed in the Appendix.

instructions as to their use. The box should contain packets of sterilized dressings, a supply of iodine solution (alcoholic solution containing 2 per cent iodine), and a bottle of "eye drops." A pair of dressing scissors, some triangular bandages, safety pins, and a roll of plaster (1 inch wide) may also be found desirable. The sterilized dressings may suitably be of three sizes: (a) Three dozen small size, for fingers, composed of a strip of gauze or lint 8 inches long and 1 inch wide, with narrow tape attached to one end. The tape should be rolled up inside the strip, which is then wrapped in a cover of ordinary nonabsorbent wool and the whole sterilized. In use the wool is first removed and the dressing unrolled round the injured finger, when the tape is disclosed ready for tying the dressing in position; (b) one dozen medium size, for hands or feet, similar to the above but 18 inches long and $1\frac{1}{2}$ inches wide; and (c) one dozen large size, for which the ordinary field dressing may be taken as a pattern. The aid post should be under the care of an officer; preferably the foreman or forewoman, trained in first-aid work. This officer should keep a note of every case dressed, and should be responsible for seeing that the box is kept stocked and in proper order. Ordinarily one such aid post should be provided in each work place, but in large engineering shops several may be required.

(b) CENTRAL DRESSING STATION OR SURGERY.

11. The central dressing station should be an easily accessible room specially constructed or adapted for the purpose. The room or rooms set apart as a central dressing station should in large factories provide for a surgery, a rest room, and a storeroom and nurse's room. Where a surgery is used for workers of both sexes, a second small room will be found advantageous. The walls should be covered with glazed tiles, enameled iron sheets, or washable paint; the floor should be of smooth, hard, durable, and impervious material; the natural and artificial lighting should be ample; hot and cold water should be laid on or be immediately available; the room should be warmed in winter. A glazed sink is needed, the pipe being well trapped from the drain. A foot bath, preferably fixed and provided with hot and cold water, is desirable. The furniture should consist of a table, a couch, chairs, and cupboards. The room should not contain a carpet, rugs, curtains, table cloth, window blinds, or wall pictures. The keynote should be simplicity and cleanliness. The floor should be washed once a day with antiseptic fluid, and the walls at least once a week.

The object of the central dressing station being the treatment of more serious cases than can be dealt with at the aid post and the redressing of cases of minor injury, it is desirable that it should be properly equipped. It may also be convenient to use it for the medical examination of applicants for work.

The station must be in charge of a competent person with knowledge of ambulance work. Wherever possible a trained nurse should be on regular duty, ambulance assistants being selected from employees trained in first-aid work. Many large works now have a medical officer on the staff, who is responsible for the supervision of the surgery and available for serious cases before removal to hospital. The equipment of the surgery will largely depend upon the character of the accommodation provided and the experience of the person in charge, but the following will generally be required:

- (i) Stretchers, splints, and strong bandages for major accidents;
- (ii) Bandages and dressings for minor injuries (a stock should be kept to replenish the aid posts);
- (iii) A simple sterilizer and necessary surgical instruments, such as scissors, forceps, and tourniquet; and
- (iv) Simple lotions and drugs (with sufficient enameled basins).

SYSTEMATIC RECORDS.

12. As already suggested, it is important that a full and accurate register should be kept of all cases of sickness and accident, with particulars of dressings, redressings, and treatment.

Inquiry at many munition factories in regard to the records of first-aid treatment indicates that advantage would be gained by the adoption of some system of keeping records. Different methods of first aid and preliminary treatment are practiced at different factories, but no comparison of results can be made, owing to the lack of records. The committee therefore suggest that a case book should be kept, drawn up somewhat as follows:

Identification number.	Date.	Name of injured person.	Nature of injury or illness.	How caused.	Progress of case with dates of subsequent dressings, and the occurrence of any sepsis.	Date of final dressing.
1	25.11.15	Mary Smith	Crushed thumb	Fall of shell	25.11.15, 23.11.15, 30.11.15	3.12.15

Each case when first treated may appropriately receive a card, numbered to correspond with the entry in the case book, to be brought on the occasion of subsequent dressings.

[This card must be brought to the surgery each time the patient comes for treatment.]

Identification number.	Name.	Nature of injury or illness.	Date.	Instructions.
1	Mary Smith.	Crushed thumb.	25. 11. 15	To come to-morrow.
			28. 11. 15	To come on 30th.
			30. 11. 15	To come on 3d December.
			3. 12. 15	

RESULTS.

13. The committee are satisfied of the urgent necessity and value of some such organization as that suggested above. They have been much impressed in visiting munition works with the useful part performed by competent nurses and the large number of cases of injury or sickness which receive treatment. In 11 moderately sized works, employing about 35,000 workers, 38,000 surgical dressings were performed in the first 10 months of 1915, varying in ratio from 19 per 1,000 employed per month to 221 per 1,000 per month. At Woolwich Arsenal the medical department is organized centrally and locally, and is at present staffed by nine (including two women) medical officers, a matron, and four nursing sisters, with a large staff of nursing orderlies, clerks, etc. In the year 1914-15 there were 150,000 attendances for treatment or medical examination. Two other munition works report that in the last half of October, 1915, their nursing staff dealt with 2,348 and 2,028 cases, respectively.

While such data point to the need for first-aid work, information obtained from another munition factory suggests that the need to-day is proportionately greater than in normal times. In the autumn of 1914, when the hours of work were from 8 a.m. to 5.45 p.m., an average of 100 first-aid dressings were done at this factory each month per 1,000 employed; in 1915, for the same period of the year, when the hours of work were from 8 a.m. to 8 p.m., the average rose to 292, and at night when the hours of work were from 8 p.m. to 8 a.m. to 508. The firm attribute the increased proportion of cases to (i) longer hours, (ii) more thorough organization of first-aid treatment, and (iii) the fact that a greater proportion of the workers are at night employed on machines as compared with daytime, when about 20 per cent of the operatives are employed on inspecting and sorting. They further state that accidents occur more frequently among workers recently engaged or moved to new work.

14. The committee have received evidence and reports from all parts of the country of the economic and industrial value of the proper organization of a medical service within the factory, and they

are convinced that both on grounds of health and of securing improved output this subject demands the immediate attention of employers, and that adequate schemes of treatment, especially of minor injuries, are an important means of preventing loss of time and efficiency among the workers. They recommend, therefore, that provision for organized treatment should be made in every munition factory.

Signed on behalf of the committee,

GEORGE NEWMAN, M., D.

Chairman.

E. H. PELHAM, *Secretary.*

JANUARY, 1916.

APPENDIX.

[A leaflet issued by the Home Office.]

A SCRATCH OR SLIGHT WOUND.

Do not touch it.

Do not bandage or wipe it with a handkerchief or rag of any kind.

Do not wash it.

Allow the blood to dry and so close the wound naturally; then apply a sterilized dressing and bandage.

If bleeding does not stop, apply a sterilized dressing and sterilized wool, then bandage firmly.

If the wound is soiled with road dirt or other foul matter, swab freely with wool soaked in the iodine solution¹ and allow the wound to dry before applying a sterilized dressing.

A BURN OR SCALD.

Do not touch it.

Do not wash it.

Do not apply oil or grease of any kind.

Wrap up the injured part in a large dressing of sterilized wool.

Do not remove any dressing, but, if the injured part becomes painful and begins to throb, go to a doctor at once.

Destroy all dressings which have been opened but not used; they soon become infected with microbes, and then are not safe to use.

EYE INJURIES.

Apply the eye drops² to the affected eyeball by means of the camel-hair brush in the bottle.

¹ An alcoholic solution containing 2 per cent of iodine.

² Instructions to chemist for making eye drops:

Cocaine	0.5 per cent,
Hyd. Perchlor.....	1 in 3,000,
in castor oil.	

Weigh 95 grams of castor oil into a flask capable of holding twice the quantity. Add 0.5 gram of powdered cocaine. Warm on a water bath till dissolved. While the solution is still warm (but not hot) add 1 cubic centimeter of a solution containing 3.3 grams of mercuric chloride in 100 cubic centimeters of absolute alcohol. Mix the solutions by rotating the flask.

About half an ounce, or 15 cc., of this solution should be supplied in a bottle from the cork of which a camel's-hair brush is pendent in the fluid.

Do not try to remove any particle which can not be brushed away.

Tie up with a clean handkerchief or bandage.

Go to a doctor *at once*.

Prevention is better than cure; therefore, if your work entails danger to the eyes,

WEAR GOGGLES.

Goggles have saved hundreds of eyes; *thousands* have been lost for want of them.

NOTE.—Danger from minor injuries arises from blood poisoning which is caused when microbes infect a wound. The majority of wounds are at first "clean" that is they are not infected with microbes; such infection usually occurs later, and comes from handkerchiefs or other materials applied to stop bleeding or to wipe away blood, and, in the case of eye injuries, from efforts to remove fixed particles with unclean instruments. *It is better to leave a wound alone than to introduce microbes by improper treatment.* The congealing of blood is nature's way of closing wounds against infection and should not be interfered with.

Burns and scalds when the skin is not broken will heal if left alone; all that is necessary is rest and a protective covering. When blisters form they must not be pricked, except under medical advice.

Rest is an important aid to healing. A short rest at first allows healing to commence and often saves a long rest later. An injured hand or finger can be rested in a sling, and an injured eye by a bandage, but an injured foot or toe can only be rested in bed.

SPECIAL INDUSTRIAL DISEASES.

[Memorandum No. 8.]

1. Work at certain industrial processes entails special risks from exposure to lead, tetrachloride of ethane, nitrous fumes, and certain explosives, each of which may cause serious and possibly fatal illness; while contact with trinitrotoluol, tetryl, fulminate of mercury, and certain lubricating and cooling fluids used in metal turning may result in the occurrence of troublesome skin affections (dermatitis). The committee recognize that this list is not exhaustive of the industrial diseases which may affect munition workers, but they consider that no useful purpose would be served by dealing with others of less immediate importance. The number of munition workers exposed to these risks, although not large when each disease is taken separately, is in the aggregate considerable; and interference with output would result if protective measures were not adopted. What these measures are is briefly indicated below. The medical aspect of each disease is only reviewed so far as is necessary to explain the reason for the precautions indicated.

LEAD.

2. *Disease and its causes.*—Operatives come in contact with lead and its compounds in a variety of processes in munition factories; in smelting lead and spelter; in making sheet lead and bullets; in file cutting; in hardening and tempering metals; in common tinning; in soldering and plumbing; in the manufacture of accumulators and of india rubber; and in the use of lead paints and red lead. Under industrial conditions lead gains access to the body principally by the inhalation of lead fumes or dust. Lead tends to accumulate in the body, and careful investigations have established that a daily dose of as little as 2 milligrams must be regarded as capable, when inhaled as fume or dust, of setting up chronic poisoning. Lead may also enter the system through the digestive tract, by eating with unclean hands, or by putting pipes or other articles into the mouth while the hands are soiled with lead. Lead is a cumulative poison, that is to say, even small doses absorbed day after day have a tendency to collect in the system and finally to cause illness. The existence of a blue line at the edge of the gums is an indication of lead absorption, and headache, colic, constipation, and marked paleness are early manifestations of poisoning.

3. *Prevention.*—The prevention of inhalation of dust or fumes has been the principle underlying the regulations established by the Home Office under the Factory and Workshop Act, 1901, section 79, for the chief industries concerned with the manipulation of lead and its compounds. Under these regulations the incidence of lead poisoning through the past 15 years of industrial expansion has not only been held in check, but has been reduced by one-half. Inhalation of lead in the form of fumes or dust can only be avoided with certainty by preventing the production of dust (for example, by keeping all lead material damp), and by insuring that lead fumes do not escape into any place in which work is carried on. The nature of certain processes, however, may render the production of dust inevitable or the escape of fumes possible. Under such conditions localized exhaust ventilation should be applied as close as practicable to the point of origin so as to withdraw the dust or fumes from the atmosphere of the workplace. Respirators may be required in a few exceptional cases, but as a protection against dust only a few of the many forms of respirator obtainable are effective, and no one of them is comfortable to wear; while as a protection against fumes no respirator exists which an operative can be asked to wear for prolonged periods.

4. To prevent lead entering the system through the digestive tract the following special steps should be taken:

- (a) Smoking should be prohibited in all places where lead is manipulated.
- (b) No person should be allowed to take a meal or to remain during the times allowed for meals in any room where lead is used.
- (c) Special provision should be made to enable the workers to take their meals elsewhere.
- (d) Special washing facilities should be provided.¹ These will only be effective if a sufficient supply of clean towels, soap, and nailbrushes is always available.

5. The manifestations of poisoning can be detected by a medical man, and their presence indicates that the worker should be trans-

¹ The standard adopted under factory regulations is as follows: The washing conveniences should be under cover, and maintained in a cleanly state and in good repair. There should be either—

- (a) A trough with a smooth impervious surface (fitted with a waste pipe without plug) and of such length as to allow at least 2 feet for every five persons, and having a constant supply of warm water from taps or jets above the trough at intervals of not more than 2 feet; or
- (b) At least one lavatory basin for every five persons, fitted with a waste pipe and plug or placed in a trough having a waste pipe, and having either a constant supply of hot and cold water or warm water laid on, or (if a constant supply of heated water be not reasonably practicable) a constant supply of cold water laid on and a supply of hot water always at hand when required for use by persons employed.

ferred to other work. The Home Office regulations require employers to have persons engaged in various lead industries examined periodically by a surgeon who is intrusted with powers of suspension from work. This form of medical supervision has been found to be of such value and has in consequence been so widely adopted even in industries not governed by regulations, that the committee desire to urge its adoption in all factories where the use of lead oxides or other of its many compounds may have recently been introduced in the manufacture of munitions. In the handling of metallic lead, *e. g.*, bullets, the risk of poisoning is very slight, and medical supervision is less important.

TRINITROTOLUOL.

6. *Disease and its causes.*—Trinitrotoluol (also known as trotyl and TNT) is, like dinitrobenzol, a substance the manufacture of which, on account of its toxic nature, is controlled by regulations. The extended use of this material, which has followed the increased demand for high explosive munitions, has brought its poisonous properties into prominence. Operatives employed in its manufacture and in loading it, either pure or mixed with other substances, into munitions have been found affected with unusual drowsiness, frontal headache, eczema, and loss of appetite. Exceptional cases may occur with sudden collapse after a few hours' work on a hot day, but generally the symptoms are at first slight and, if exposure ceases, quickly disappear. If, however, the exposure be continued, the symptoms tend to become more severe and may be associated with cyanosis (ashen gray and livid color of the lips), shortness of breath, vomiting, anemia, palpitation, bile-stained urine, constipation, rapid weak pulse, pains in the limbs, and jaundice; while in a few cases profound jaundice with danger to life has supervened; and even death has resulted.

7. *Prevention.*—Trinitrotoluol, like nitro derivatives of benzene, may be absorbed by inhalation of vapor or dust, through the skin, and through the digestive tract; and at least the following preventive measures should be taken accordingly:

- (a) Every possible step should be taken to prevent the production of dust and the escape of fumes into the air of workplaces. Persons employed in packing trinitrotoluol, or at other processes in which the production of dust is unavoidable, should be called upon to wear respirators. When melted, trinitrotoluol gives off fumes, and arrangements should be made by localized exhaust ventilation for all fumes to be discharged into the outside air without escaping into the work place;

this can be effected by inclosing the vessel containing the melted trinitrotoluol in a bell-shaped hood terminating in an upcast shaft about 20 feet in length, guarded at the top by a cowl. The working opening to the hood should only be of sufficient size to permit necessary manipulations.

- (b) To protect the skin overalls should be worn; the sleeves of the overall should fasten at the neck and the wrist and have no opening in the cuff. Gloves of leather, strongly sewn, have been recommended, and, if worn, the cuff of the glove should be inside, that is under, the sleeve of the overall. Where women are employed head coverings should be worn.
- (c) To prevent absorption through the mouth the same preventive measures should be taken as in the case of lead (see par. 4 above); the provision and maintenance of adequate washing accommodation is specially important. Output has been so urgently required that at some factories work has commenced before building has been completed; at one such factory many cases of troublesome dermatitis (eczema¹) occurred and caused considerable interference with work, but as soon as suitable lavatories were completed the trouble ceased.
- (d) The period of exposure should be reduced to a minimum and should not be prolonged by overtime.

The slow and progressive action of the poison allows further precautions to be taken, and periodical medical examination, with power to suspend from employment any person who is affected should, therefore, always be arranged; indeed this has already been extensively done with beneficial results.

The necessity for adopting preventive measures was recently shown by the death of a woman, aged 22 years, exposed during about 5 weeks' employment in a munitions works, to dust generated in manipulating a powder containing a moderate amount of trinitrotoluol. She left her home, which was 5 miles from the factory, often without sufficient food, at 4.45 a. m.; and no adequate provision was made for her to take food on arrival before commencing work at 6 a. m. Washing conveniences were primitive, cloakroom and overall accommodation was inadequate, and personal supervision was insufficient. At the same factory several other less severe cases of illness occurred. Probably such cases can be avoided by attention to details, in particular by using means to prevent dust and by insuring that sufficient food is taken before work commences.

¹ An application found of value to prevent eczema is a mixture of two parts of castor oil to one part of lanoline; this mixture, which should be rubbed into the skin after washing on leaving work, should be placed in the lavatories for general use.

TETRYL (TETRANITROMETHYLANILIN).

8. *Disease and its causes.*—Manipulation of this explosive produces a light dust, which may cause troublesome eczema. Individuals vary in their susceptibility; some appear to be almost immune, while others can hardly enter a room where tetryl is handled without suffering severely. Observation suggests that this may depend on the varying natural dryness or moistness of the skin of different persons. The parts most frequently affected are the conjunctivæ, the openings of the nostrils, and the chin. The hands and arms are less often affected, and in this the eczema caused by tetryl differs from that due to trinitrotoluol, which usually affects the forearms and hands. Operatives manipulating tetryl may also suffer from headache, drowsiness, and lack of appetite in varying degrees of intensity; but the committee understand that up to the present no case of illness endangering life has come to the notice of the Home Office.

9. *Prevention.*—The principal measures to be taken consist in—

- (a) Avoiding the escaping dust by carrying out manipulations in glass cupboards with armholes for introduction of the hands.
- (b) Providing light gauze veils to protect the faces of the workers.
- (c) Supplying, if veils are not worn, some simple powder (such as a mixture of one part zinc oxide to two parts starch) for applying to the face before beginning work.
- (d) Providing adequate washing accommodation (see footnote on page 74), and encouraging the use after washing of an application for the skin.¹
- (e) Excluding workers who show special susceptibility or idiosyncrasy.

10. Apart from its tendency to cause eczema, tetryl stains the skin and hair; in order to prevent this, overalls and gloves, similar to those recommended for workers manipulating trinitrotoluol (see paragraph 7 above), should be worn, and, where women are employed, suitable head coverings should be used.

FULMINATE OF MERCURY (CNO₂)Hg.

11. *Disease and its causes.*—In the manufacture and use of fulminate of mercury there is a liability of mercurial poisoning and eczema. Owing, however, to the small amounts manipulated, the symptoms of mercurialism are seldom marked; but a blue line may be seen on the gums, appetite may be impaired, headache may be

¹ See note on page 76.

present, and there may be nervousness and depression. The last symptom is important, not merely as a sign of illness, but as an indication that the operative should be removed from dangerous work which calls for a steady hand and clear head. Eczema of the hands, forearms, and face occur, and may cause serious disability.

12. *Prevention.*—Measures to prevent these conditions from arising should include—

- (a) Provision of overalls and of adequate washing accommodation.
- (b) Transference to other work of those specially affected.
And,
- (c) Where exposure is marked, periodical medical examination.

TETRACHLORETHANE.

13. *Disease and its causes.*—Tetrachlorethane is a noninflammable liquid and a solvent for acetate of cellulose. It has formed an ingredient of the “dope” varnish applied to the canvas coverings and tapes of aeroplane wings, and to aeroplane bodies, in order, by impregnating them with cellulose, to render them impervious to moisture and air. This liquid is volatile at ordinary temperatures; its vapor smells like chloroform, is a powerful anesthetic, and, being twice as heavy as air, tends to sink to the floor. The poisonous effect of the vapor depends not only on the amount of vapor in the air, but also upon the time for which the air is breathed. Inhalation of this vapor, even in small amounts, when spread over prolonged periods, has caused drowsiness, loss of appetite, constipation, and pains in the stomach; and, in more serious cases, jaundice, liver destruction, coma, and death.

14. *Prevention.*—The committee are glad to learn that an apparently effective varnish has been found which does not contain the poisonous chemical, though unfortunately the supply of its ingredients is at present insufficient to meet the demands. Meanwhile strict precautions should be taken to lessen the risk associated with its use:

- (a) The number of workers exposed to the vapor should be reduced to a minimum; all processes of “doping” should be in a separate place where no other work is undertaken. At first, before the poisonous nature of the vapor was recognized, this precaution was not taken and workers employed on other operations suffered in consequence.
- (b) Adequate exhaust ventilation must be arranged for; if the ventilation is to be adequate and sufficient to sweep away the heavy vapor, the entire air contents of the workroom should be extracted (preferably by volume

or propeller fans), at or near the floor level, about 30 times every hour, while for admitting fresh air supply there should be high up in the room numerous hopper openings, the combined superficial area of which should be at least three times that of the area of the exhaust openings.

- (c) Operatives should not be allowed to remain in the work place during meal hours.
- (d) The process of "doping" should as far as possible be alternated with other work.
- (e) The period of exposure should be reduced to a minimum and not prolonged by overtime. Ventilation on the lines suggested above is only adequate to bring the amount of vapor inhaled within safe limits for ordinary hours of work. Undue extension of these hours not only lengthens the exposure, but lengthens it for individuals who being already tired are less able to resist it.
- (f) Periodical medical examination should be provided for, with power to suspend from employment any persons affected.

PERSONAL HEALTH IN RELATION TO INDUSTRIAL POISONS.

15. The poisons so far considered have two points in common, more or less prolonged exposure before symptoms develop and personal susceptibility. Cases of poisoning may occur among men who have worked for a long time previously without any apparently ill effect, while others who suffer on commencing work may later on preserve their health with unaltered conditions. These apparent anomalies probably depend on varying conditions of personal health, an individual in good health resisting a dose to which he may succumb if, for any reason, he is overtired or subnormal. Maintenance of good health, therefore, is even more important for workers exposed to these poisons than for other workers. Two matters are of special importance in this connection:

- (a) Workers should not commence work without having taken food, for evidence shows that hungry and ill-fed workers succumb more readily than others. Such workers should be supplied with at least half a pint of milk or cocoa before starting work in the morning. This practice, the committee are informed, has been followed with excellent results for many years in certain factories where there is danger of lead poisoning. At the present time when women, who as a class are less concerned about their food than men, are being so largely employed, the practice should, in the opinion of the com-

mittee, be adopted for all workers exposed to these poisons. Moreover, study of output indicates that generally in factories less work is done per hour from 6 a. m. to 8 a. m. than after the breakfast interval, and the committee consider this is largely due to workers hurrying to the factory without previously taking food. The establishment in munition factories of the canteen system, as advocated in an earlier memorandum, should provide an effective means for dealing with this matter.

- (b) Workers exposed to poisonous substances should be carefully chosen. Only healthy and temperate persons should be employed.

NITROUS FUMES.

16. The present demand for explosives, nearly all of which are products of nitration, has introduced increased risk of exposure to nitrous fumes, not only in nitrating processes, but also in the manufacture of nitric acid to be used in these processes. A memorandum dealing with the danger from these fumes, especially in relation to the present risk, has recently been issued by the factory department of the Home Office, and the committee consider that advantage may accrue from drawing the attention of employers to this memorandum with which they are in entire agreement:

In the manufacture of nitric acid, and in its use for various purposes, particularly in the manufacture of explosives, danger exists of accidental escape of nitrous fumes into the work places. The full effect of inhaling these fumes is not felt immediately, and unless workers are warned of the danger, they may continue at work and unwittingly inhale a fatal dose.

In such a case the affected person develops an irritating cough which becomes steadily worse, until, three or four hours after exposure, he becomes seriously ill, suffering from marked dyspnea and collapse; sometimes these symptoms have come on after leaving work on the way home. The secretion of mucus now becomes profuse, and vomiting, which helps to clear the air passages, may occur. The congestion of the bronchioles and alveoli progresses, and, if the case survives 48 hours definite pneumonic consolidation may develop. More frequently a fatal issue results in about 30 hours, the patient remaining conscious until near the end.

Every case exhibiting the initial symptoms does not progress to a fatal termination, and recovery has occurred even after marked collapse and dyspnea.

Prevention.—Notices warning those employed of the danger of remaining in an atmosphere containing nitrous fumes should be posted in every place where there is any possibility of these fumes escaping.

Emergency helmets of a pattern which can be easily and quickly put on, and provided with a fresh air supply from without, should be kept in accessible places near at hand, and the efficiency of such helmets should be tested at least once a month.

Respirators such as are efficient to intercept dust are useless against gases, and must not be used.

Treatment.—The following routine may usefully be pursued pending the arrival of a medical man:

Make the patient lie down.

Keep him warm.

See that he has plenty of fresh air.

If he is blue in the face—

(i) administer oxygen; and

(ii) if he has not been sick, give a drink of 1 ounce of salt in 10 ounces of lukewarm water and repeat the dose until he is sick;

(iii) meanwhile send for a doctor.

Persons even apparently slightly affected must not be allowed to walk home until permitted to do so by the doctor.

DERMATITIS.

17. *Disease and its causes.*—The occurrence of serious dermatitis, or eczema, caused by exposure to trinitrotoluol and to tetryl has already been referred to, and similar trouble may result from exposure to fulminate of mercury. Apart, however, from these special substances, eczema is liable to occur among munition workers employed in engineering works, who come in contact with certain fluids used to lubricate and to cool metals. Two forms of inflammation of the skin, which, however, may coexist, result—(1) yellow pustules and boils, and (2) more general inflammation which in marked cases develops into typical weeping eczema. Probably the occurrence of pustules and boils is due to sebaceous glands and hair follicles becoming blocked and infected with oily grime rubbed in by soiled overalls. The more general inflammatory conditions appear to be caused by the direct action of the fluids used.

18. *Prevention.*—Clean overalls, and the provision and use of suitable washing accommodation with hot water laid on, go far to prevent cases of pustules and boils. The committee have observed that reasonable facilities for personal cleaning after work are seldom provided in engineering factories, and desire to say that in their opinion, even apart from questions of health, the provision of such facilities should be considered a necessary part of the equipment of every factory.

Experience has shown that, if lubricating and cooling fluids contain a small amount of some antiseptic, say carbolic acid up to 1 per cent or other coal tar antiseptic, cases of eczema do not occur. The committee have learned with satisfaction that so-called antiseptic lubricants and cooling fluids are rapidly coming into general use in engineering shops, and that cases of eczema are less prevalent than formerly. They consider that against this condition also good washing conveniences are a powerful preventive.

GENERAL.

19. Facilities for the prompt treatment of all cases of sickness and injury are of special importance in factories where poisonous substances are used. The nature and extent of the facilities necessary have already been discussed in the committee's memorandum on "Sickness and injury" (Memorandum No. 10). Careful instructions should be drawn up and issued to every worker and also to every person in charge of a dressing station.

20. Various leaflets and memoranda dealing in greater detail with industrial diseases and their prevention are issued by the factory department of the Home Office. The committee desire to acknowledge the help they have received from Dr. T. M. Legge, senior medical inspector, in drawing up the present memorandum.

Signed on behalf of the committee,

GEORGE NEWMAN, M. D.,
Chairman.

E. H. PELHAM, *Secretary.*

FEBRUARY, 1916.

TETRACHLORETHANE POISONING.¹

By T. M. LEGGE, M. D., H. M. Medical Inspector of Factories.

Poisoning by chlorine derivatives of ethane and ethylene.—Before the illnesses due to inhalation of tetrachlorethane, of which jaundice has been so prominent a symptom, came to my notice, occurrence of jaundice as a symptom of industrial poisoning had been familiar to me as following on, first, inhalation of arseniureted hydrogen gas in chemical works, and, secondly, absorption of nitro derivatives of benzene in factories for the manufacture of explosives. Poisoning by arseniureted hydrogen, of which some 70 cases have come to the knowledge of the factory department during the last 15 years, is characterized by the rapid development, in the course of a few days, of an intense coppery jaundice, no doubt hæmohepatogenous in character. In the first instance a destruction by the gas of the elements of the blood takes place with subsequent increased formation, from the hæmoglobin liberated, of bile pigments in the liver, which lead to increase in the viscosity of the bile and temporary obstruction of the ducts. Onset of the symptoms is usually within a few hours of exposure. The jaundice observed in cases of absorption of nitro derivatives of benzene is of the same kind and is caused by the hæmolytic action of the compound on the blood with formation of methæmoglobin. I have never seen or heard of jaundice produced industrially from phosphorus.

On thinking over whether there was any other process in my experience which had given rise to jaundice, I recalled having once, on complaint, examined a number of women engaged in an india rubber factory, obtaining from them evidence of gastric derangement and, in addition, from one of them a history of "yellow jaundice." The solution which they were using was a mixture of carbon tetrachloride and chloride of sulphur in equal parts.

The chlorine derivatives of ethane and ethylene have recently been produced by an inexpensive process, and as they are noninflammable, noncombustible, and nonexplosive the reason for their use as solvents of fat, resins, and rubber, in preference to benzene, carbon bisulphide, alcohol, ether, and turpentine, is obvious. Explosions from benzine in industrial premises, as, for example, that of a few years ago at a large oil-cake works at Liverpool, from naphtha, and from carbon bisul-

¹ Great Britain. Factory inspector's office. Annual report of the chief inspector of factories and workshops for the year 1914. London, 1915. Pp. 107-112.

-phide, have been attended with loss of life and much damage to property.

Of these derivatives *trichlorethylene* (C_2HCl_3) is that which has come most into use, mainly for the extraction of oil from seed and for the removal of grease spots in dry cleaning. In one oil-extracting works where the process of extraction was done automatically in closed iron chambers and every effort made to remove the last traces of trichlorethylene before the seed was withdrawn, no case of jaundice had occurred among the seven men employed. The conjunctivæ, however, were muddy and injected, and one of them, six weeks before I saw him, after working a short time was seized with vomiting and removed to the infirmary. The physician's notes were, briefly: "Vomiting; very violent and excited on admission; could give no account of himself; appeared dazed and had both pupils contracted." His condition was put down to epilepsy. Another worker, in charge of the reservoir in the basement, stated that he had been once rendered insensible by the fumes, and one of the principals of the firm suffered from a severe bilious attack the first day he took over the management of the department. So far I have visited but few premises in which trichlorethylene is used in other than small quantities and so can not express further opinion as to its toxic quality. No case of jaundice has come to my knowledge.

A paint containing trichlorethylene, used almost exclusively in the brewing industry for coating the inside of fermenting vats and casks, caused the death of a man engaged in applying it. The paint has the merit of noninflammability. Directions for its use issued by the makers recommend (1) the workman to wear "an india rubber tube, one end of which is fitted to a mouthpiece and the other end secured to a point above and outside the vessel undergoing treatment," of which they supply a special form, and (2) application of a "suction pump to the cleaning-out vent in the bottom of the vessel, whereby the heavier fumes are withdrawn."

Tetrachlorethane ($C_2H_2Cl_4$) is used mainly as an ingredient of the varnish or "dope," as it is called, for covering the wings of aeroplanes to make them impervious to moisture and air. This "dope" consists of powdered acetate of cellulose dissolved in various organic solvents such as acetone, amyl acetate, benzene, carbon tetrachloride, tetrachlorethane and others, in order to bring the cellulose to the needed dilution. Acetone is the best solvent apparently, but the current price of it is about £100 (\$486.65) per ton, whereas tetrachlorethane is only £28 (\$136.26) per ton. And, moreover, tetrachlorethane seems to have the remarkable property of tightening up the fabric which is stretched to form the wing in a way that nothing so far tried can do.

The development in the manufacture of aeroplanes has been rapid, carried on as it is now in at least 27 factories, employing, roughly, some 6,500 workers. In one factory alone 1,500 hands are employed. Perhaps 300 persons—men and women in equal proportions—are engaged in doping operations, but before the recent occurrence of poisoning a far greater number than this was exposed to the fumes, as in only a few factories was the process separated off from the general atmosphere of the usually large shed in which the wood working, fitting, and erecting processes were carried on. Further, in order to keep the fabric dry—considerable importance being attached to this, as the fabric, if moist, tends to rot under the varnish—the air was kept at a temperature of about 65° F., or more, and ventilation intentionally reduced to a minimum unless the air introduced was warmed. The wing surfaces vary in size—from 20 to 30 feet long by 6 to 8 feet wide in biplanes, and perhaps 20 by 10 in monoplanes, thus affording many square yards of evaporating surface. Four to six coats of varnish are applied, each coat being allowed to dry before the next is applied. In order to secure finish two men work simultaneously opposite one another on either side of the plane. Each carries the “dope” mixture in a can in his left hand and brushes it on to the wing supported on trestles with his right. In large factories where the output amounts to, say, three aeroplanes a week, as much as 80 gallons may be used per week, and as the dope is of value in proportion to the rapidity with which it dries, the amount of fume evaporated may be imagined. On the outbreak of the war not only was the personnel largely increased but also overtime was worked in the large factories, the hours being from 6 a. m. to 9 p. m., with half an hour's break for breakfast, one hour for dinner, and half an hour for tea. In the factory where incidence has been greatest there was no available place for the mess room, so meals even had to be taken in the shop, and the sanitary accommodation (sufficient for the needs before the war) became inadequate, plans for extension having to be submitted to the urban district council.

It may be well to deal first with this factory, as Dr. W. H. Willcox and I found it early in December. The premises consisted of one large shed, of a superficial area of about 32,400 square feet, with a double-ridged roof. There were windows in the walls; the main lighting, however, came through the whole length of the ridged roof. Natural ventilation was arranged for by three large lantern openings at intervals along the two ridges. Mechanical ventilation which, it is important to note, played a part in the outbreak, was arranged on a plenum system—a high-pressure fan distributing warmed air near the ground level through well-arranged tapering trunks with subsidiary branch ducts.

"Doping" was carried on by about five men in the part of the shed farthest from the main entrance. The portion of the room where it was done was not screened off from the general atmosphere of the shed, nor was there any attempt at local removal of the fumes. The peculiar smell given off by the "dope" was distinctly perceptible on entering the building. In the vicinity of actual "doping" it was very strong. The head "doper," however, who had done the work for nearly a year, only complained of drowsiness caused by it. Questions addressed by Dr. Willcox and myself to men and women (about half a dozen women only are employed in sewing strips of fabric together) at the benches on the carpenter's landing elicited evidence of recent gastric attacks which, however, had not caused absence for more than a day or two and had been unattended by obvious jaundice. Some of them looked poorly. The accompanying list gives the order in which the cases succeeded one another, the precise occupation, the date of illness, the date of return to work, and subsequent further absence either from renewed illnesses because of the decision of the firm not to reemploy them at that time.

No.	Date started.	Department.	When left.	When returned.	When left (second time).	Remarks.
1	5, 6, 14	Fuselage shop.....	15, 9, 14	.....	.....
2	13, 9, 14	Assembling plane.....	17, 10, 14	2, 11, 14	20, 11, 14	
3	12, 8, 14	Front elevator.....	17, 10, 14	.....	.....
4	12, 8, 14	Spars.....	17, 10, 14	27, 11, 14	30, 11, 14	Left by order.
5	8, 8, 14	Fabric doping.....	24, 10, 14	.....	.....	Died, 25, 11, 14.
6	31, 8, 14	Ailerons gallery.....	27, 10, 14	30, 11, 14	30, 11, 14	Left by order.
7	13, 8, 14	.....do.....	7, 11, 14	.....	.....
8	22, 9, 14	Assembling plane.....	10, 11, 14	.....	.....
9	19, 6, 14	Panel beating.....	11, 11, 14	26, 11, 14	27, 11, 14	Paid off, 30, 11, 14.
10	6, 10, 14	Fitters.....	11, 11, 14	23, 11, 14	30, 11, 14	} Left by order.
11	12, 8, 14	Spars.....	12, 11, 14	30, 11, 14	30, 11, 14	
12	13, 8, 14	Fuselage shop.....	14, 11, 14	27, 11, 14	.....	Paid off, 27, 11, 14.
13	22, 9, 14	Assembling plane.....	14, 11, 14	.....	.....
14	22, 9, 14	Fabric.....	23, 11, 14	.....	.....
15	22, 8, 14	Assembling plane.....	30, 11, 14	.....	.....
16	20, 8, 14	Fitters.....	30, 11, 14	.....	.....

Incidence was greatest in the neighborhood of the doping area, where 8 of the cases (including the fatal case and the 2 which have proved most severe) were employed. Cases 3, 4, 6, 7, and 11 are also not difficult to account for in the same way. It is more difficult to explain cases 9, 10, and 16, who were working quite 50 yards away. They did not appear to me to have been severe attacks. There is free communication between the erecting shop and the fitters' shop, where they worked, both above the general and private office and by a wide opening between the private office and the main entrance. The vapor of the dope is twice as heavy as air, and it has therefore had a tendency to keep near the floor level. I believe the plenum system of ventilation served simply to stir up the vapor and to distribute it in all parts of the shed.

The "dope" used was that known as emallite No. 1, and contained about 12 per cent of tetrachlorethane. Other varieties contain a considerably higher proportion. I visited the premises where the mixture was prepared. The quantities having been weighed out are placed in revolving drums. While mixing in these revolving drums goes on no smell is noticeable in the room. No chemical action is believed to take place. When the acetate of cellulose has been dissolved the material is emptied into large jugs and transferred from there to barrels, where it is stored.

I examined the three men employed. Work here was commenced two years ago. One man had been employed for the whole two years, another for four months, and the third for four months. None showed any sign of effect from the fume. The short duration of employment of one of the men was due to his taking the place of a workman who enlisted. A volume fan, electrically driven, was placed in the wall of the room in which the drums were placed and was in action at the time of my visit. The foreman spoke of the value of the fan in removing the fumes. Subsequently, on the 4th of December, I visited the premises again and took samples of "dope" No. 1, and of each of the ingredients separately, and delivered them personally to Dr. Willcox at the medical department of St. Mary's Hospital.

I ascertained that another firm manufactured a dope in common use known as cellon. On going there I obtained all the information I wanted. As in the case of emallite, the mixing is done in closed, revolving cylinders; the shed is well open to the air, and no sign of illness in the two men employed has ever been noted. The composition of the dope varied only slightly from that of emallite No. 1, and contained about 11.5 per cent of tetrachlorethane.

I obtained the addresses of the 16 men absent on account of jaundice, and saw 8 of them in their homes. I tried also, whenever possible, to see the medical man in attendance. I arranged for 6 of these subsequently to attend at Dr. Willcox's out-patient department, St. Marys Hospital. The symptoms in all were remarkably uniform. The rapidity with which the attacks followed one another when pressure of work became abnormal—a considerable amount of overtime had been worked since the beginning of August—was remarkable. The jaundice showed itself in about six weeks' time. The symptoms appear to have been accompanied by little, if any, fever. The men complained at first of drowsiness and of a nasty taste in the mouth and of effects on the throat. There was a sickly feeling and marked distaste for food. In at least two of the cases seen by me meals taken to the factory could not be eaten, so that a condition of semistarvation was set up. There was, as a rule, very obstinate constipation, and in some cases vomiting. With the onset of jaundice

the stools became clay colored and the urine thick and very dark in color. Pain over the region of the liver and stomach was a prominent symptom in some. Two of the men seen reported that on recovery from the jaundice they went back to work, but after a few days jaundice returned in a more pronounced form. In very severe cases hæmatemesis or convulsions may occur. Coma supervenes, and death results with suppression of urine. All but 2 of the 8 men seen by me were convalescent. All the cases examined by Dr. Willcox on the 12th of December showed signs of enlargement of the liver. None of the men had obvious anemia, and the condition in this respect, therefore, differs from the hæmatogenous jaundice not infrequent in workers coming into contact with nitroderivatives of benzene, which cause hæmolysis of the red-blood cells. They bore no resemblance to workers coming into contact with anilin or dinitrobenzol.

The post-mortem changes have been most marked in the heart, liver, kidneys, and mesentery. The notes of one typical case, a female aged 19, are as follows:

The skin was intensely jaundiced. The liver was hard and firm; it was very yellow and showed marked congestion; weight $34\frac{1}{2}$ ounces. The kidneys showed marked yellow staining of the cortex, the pyramids being intensely congested. The medulla was yellow and congested. The kidneys weighed each 5 ounces. The heart weighed $7\frac{1}{2}$ ounces. The muscle showed yellow staining; some pink staining of endocardium. Numerous petechiae were present over surface of left ventricle. The small intestine showed intense petechial hemorrhage over the surface. There was marked congestion of the small intestine. The spleen weighed 8 ounces; it was hard and firm. Microscopical examination of the liver showed extensive necrosis, and in the kidney fatty degeneration was present.

Experiments were instituted by Dr. W. H. Willcox,¹ at the request of the Home Office, to test each of the constituents of the dope and the dope itself as regards the toxic action of the vapor on the liver. His report on this aspect of the subject which interested him exceedingly—an interest which has been of the greatest help and value to the factory department—was as follows:

"For each experiment a large glass chamber (desiccator) was used. In the bottom of this were placed daily 10 c. c. of the liquid to be tested. A perforated zinc platform was stretched across the middle of the chamber, i. e., half way up. On this were placed the animals (white rats) to be experimented upon. The top of the chamber was covered with a perforated zinc roof. Rats

¹ An outbreak of toxic jaundice due to tetrachlorethane poisoning, by W. H. Willcox, *Lancet*, Mar. 13, 1915.

were selected as the most suitable animals. The animals were kept in the glass chamber for eight hours a day for a week.

"The liquids tested were dope, tetrachlorethane, acetone, benzene, and methylated spirit, respectively. Two rats were placed in each chamber, five experiments being carried out together.

"The rats thus exposed to dope vapor and tetrachlorethane vapor became very drowsy and slept all day. After removal from the chamber they remained drowsy for some little time, and on some occasions they were quite ataxic in gait, falling over on to their sides. After an hour or more usually they fed and became active. These animals did not gain in weight during the week's treatment.

"In the experiments with acetone, benzene, and methylated spirit the animals were drowsy while exposed to the respective vapors, but on removal from it they immediately became lively and fed well. No ataxic symptoms were observed. All these animals gained markedly in weight during the week.

"After seven days' treatment the animals were killed and post-mortem examinations were made on them by Dr. Spilsbury and myself. The tetrachlorethane rats showed marked changes in the liver to the naked eye, there being fatty degeneration and bile-staining present. The dope rats showed similar changes, but less marked. The rats exposed to the vapor of benzene, acetone, and methylated spirit showed no changes in the liver to the naked eye.

"Careful microscopical examination of the organs showed marked fatty degeneration and cloudy swelling in the liver and kidneys of rats exposed to dope vapor and tetrachlorethane vapor, but no abnormal change in the animals exposed to the other vapors. Rats were also exposed to the action of dope vapor and tetrachlorethane vapor for five weeks. Marked diminution in size of the liver occurred in each case. The liver and kidneys were pale on section. They showed cloudy swelling and fatty degeneration."

The above experiments showed conclusively that tetrachlorethane is a powerful liver poison, and also they showed that dope vapor is a liver poison, and that the poisonous property of dope vapor is due to tetrachlorethane being present in it.

I have visited several of the aeroplane factories and examined all the persons in them employed in doping and certain others working near them. Having already dealt so fully with the conditions in the factory where incidence has been highest, I summarize merely the conditions found in the others. Nearly all the premises were new, cubic space ample, and the conditions for normal work not involving exposure to poisonous fumes excellent. The seaplane works are on the edge of the sea, and the natural thorough ventilation in them was in itself almost sufficient to neutralize the effect of the fumes. Inquiry in one factory brought to light the significant fact that as

long ago as February, 1913, one man employed in doping had died, the symptoms being those of acute yellow atrophy of the liver. Here also a fellow worker, whom I saw, had also suffered at the same time from jaundice and other typical symptoms, although he had not given up work. Work had been carried on in a confined space, and probably with a dope containing high proportion of tetrachlorethane. In another factory a man testing the engine suffered in the middle of the year, and in yet a third I saw a man who had had jaundice in August last—all these cases, therefore, dating from a time anterior to the war pressure.

Altogether I have traced 25 cases, including 4 deaths,¹ in which jaundice has been the prominent symptom; many others have suffered from gastric and intestinal symptoms without jaundice noticeable to themselves or their friends, and from symptoms diagnosed as "influenza" and "tonsillitis."

The fact that the vapor is twice as heavy as air has had noticeable effect in affecting workers engaged at sitting work near the place where doping was carried on. One seamstress died, partly, no doubt, as the result of her relatively lower position. In another factory six men engaged in wire splicing and seated on benches in a portion of the doping room screened off by a low wooden partition exhibited more marked effect than the dopers who were standing.

As soon as the danger was recognized the factory department, in conjunction with the Admiralty and War Office, took prompt action. All firms were asked (1) to carry out doping in a separate shop or portion of a larger shop screened off so as to limit the number of persons exposed to the fumes; (2) to provide exhaust fans at the floor level to remove the vapor which is heavier than air directly into the outside atmosphere; (3) to permit no workmen or women to remain in the doping shop during meal times.

It has interest to follow the steps taken to minimize the danger. The person who experiments with the ingredients with a view to perfecting the dope wears a smoke helmet; that is, a mouthpiece fitting over the nose and mouth and communicating with the outside air by a long, flexible pipe. Through this he inhales fresh air, breathing of the contaminated atmosphere being prevented by a valve through which he exhales only. Workpeople, however, can not be expected to wear such an apparatus, except for short periods for cleaning operations or rescue work. Seeing that the vapor of tetrachlorethane is considerably heavier than air (the specific gravity is 1.6), district inspectors recommended thorough ventilation of the room with mechanical exhaust below the breathing level, drawing

¹ One further death of a woman (with considerable length of employment before exhaust ventilation was installed) occurred in February, 1915.

the air down and away from the workers. As it was thought possible that under certain conditions the vapor arising from the varnish might form an explosive mixture with air, attention had to be directed to this danger in connection with the installation of power for the exhaust ventilation. Locally applied exhaust ventilation was not thought possible at first, owing to the size of the aeroplane wings, the general guiding principle being to introduce air (preferably warmed) at a point on one side of the room considerably above the workers' heads and extract it by volume fans placed at the ground floor opposite the air inlet. In some cases the downward exhaust was arranged through gratings in the floor. As, however, two men are doping at the same time, the one nearest to the fan could not escape inhaling some of the vapor. To avoid this and to reduce still further the amount of vapor in the atmosphere, one firm successfully arranged for actual doping to be done on the wings placed on trestles in long boxes with flap sides, the bottom of the box being connected up with a volume fan. Thus the whole surface of the wing was swept by moving air, which constantly passed to the exhaust.

The use of tetrachlorethane and of other substances such as carbon tetrachloride (which might be expected to have similar detrimental effect on the health) has been entirely dispensed with by one or two firms; others maintain that no substance so far tried gives such flexibility and durability as a dope containing some proportion of tetrachlorethane.

After occurrence of the outbreak in this country, I ascertained that late in 1913 and in the beginning of 1914 the same trouble had been experienced in Germany. In one factory, among 15 persons employed in doping, 12 were affected, of whom 2 had died. The symptoms fell into two clearly defined types. In the one the symptoms had been nausea and vomiting, feeling of general discomfort, pains in the stomach, and marked jaundice with enlarged liver. In one instance basophil granules were observed in the red-blood cells. In the other group, in addition to loss of appetite and nausea, nervous symptoms predominated—marked tremor of the hands, pins-and-needles feeling in the hands and feet, diminution or loss of the knee jerks, headache, pains in the limbs, and excessive sweating. The dope contained from 30 to 50 per cent of tetrachlorethane. In 1911 Prof. K. B. Lehmann made comparative experiments as to the poisonous nature of a number of chlorinated hydrocarbons, among them being tetrachlorethane. Commencement of narcosis was taken as the measure of the poisonous nature. Slight narcosis was caused in cats with a proportion of 5.7 mg. per liter within $4\frac{1}{2}$ hours, and severe narcosis in $5\frac{1}{4}$ hours. With stronger proportions, the animals were generally clearly ill on the following day. Judging by this

standard of the commencement of narcosis, when compared with other chlorine derivatives of hydrocarbons, tetrachlorethane comes out as much the most poisonous, e. g., nine times as poisonous as carbon tetrachloride and four times as poisonous as chloroform. In experiments on chronic poisoning, the animals exposed to air containing 1 to 2 mg. of tetrachlorethane per liter for four weeks, over a period of 67 hours, showed slight or severe drowsiness and a not inconsiderable diminution in body weight. No post-mortems were made.

Even if, as is to be hoped, use of tetrachlorethane may be eliminated from the dope, I am still of opinion that exhaust ventilation will be necessary to prevent ill effects (dryness of throat, headache, giddiness, amblyopia, and even unconsciousness) from such solvents and diluents as benzene, acetone, and methylated spirit, which must necessarily continue to be used.

DOPE POISONING.¹

Continued incidence of poisoning in aeroplane factories has led to the addition of the main symptom caused by tetrachlorethane—toxic jaundice—to the diseases which, if contracted in a factory, must be notified to the factory department. The occupier [employer] is required to report every such case to the district inspector and to the certifying surgeon, and the medical practitioner in attendance has also to report it to the chief inspector. (S. 73, Factory Act, 1901, and order of Nov. 27, 1915.)

Not every symptom set up by tetrachlorethane, it should be observed, is reportable. The requirement is limited to the serious sign of *jaundice*, and in view of its unmistakable character the difficulty of compliance should be small.²

Tetrachlorethane (of which the specific gravity is twice that of air) is a most powerful cumulative liver poison, even when present in the dope mixture to the extent of only 10 or 12 per cent. Among some 43 cases of jaundice in aeroplane factories which have come to the knowledge of the department there have been 7 deaths (2 males and 5 females). The fatal issue generally has occurred in about a fortnight after the apparently slight initial symptoms had shown themselves.

The size of the aeroplane wings unfortunately makes it impracticable to remove the vapor completely at the point of origin by local exhaust which would carry it off without allowing any to pass into the air of the room. Reliance, therefore, in minimizing the noxious effect has to be placed on dilution of the air so as to keep down the tetrachlorethane and other vapors to a nontoxic proportion. The standard needed for securing this is 30 changes of the air of the doping room per hour. Where this standard has been secured and maintained for all processes in which tetrachlorethane in dope may be used illness, if not altogether prevented, has ceased to cause serious anxiety. On the other hand, where it has fallen short of 20 changes toxic jaundice has not failed eventually to show itself except in the

¹ Great Britain. Factory Inspector's office. Form 356, Dope poisoning. Feb., 1916.

⁴ pp.

² On the other hand, "dope poisoning," i. e., any illness attributable to the ingredients of the dope, has been added to the schedule of diseases to which section 8 of the Workmen's Compensation Act, 1906, applies.

few factories where use of dope has been so intermittent as never to have exposed the workers to a toxic dose.

The means of ventilation must be mechanical, preferably by volume or propeller fans with free discharge to the open air. Owing to the high specific gravity of the vapor the fans should be fixed at the floor level or below this level where space allows the construction of large ducts under the floor. Air inlets of the hopper type, the total area of which should be not less than three times the discharge area of the fans, should be provided at the side of the room opposite the fans at a height of about 10 feet above the floor level. Exceptionally, however, where the fresh air is supplied by a satisfactory plenum system or direct from the erecting shop over a partition of sufficient height, screening the doping room from the rest of the shop, such air inlets may be unnecessary.

Owing to varying conditions of construction in different factories it is impossible to standardize methods of ventilation for doping rooms, but in new works or extension of existing plant plans of proposed ventilating arrangements should be submitted to the inspector for dangerous trades, Home Office, before the work is put in hand.

At the commencement of the war several cases occurred among persons employed in fabric making, erecting fittings, etc., before exhaust ventilation and separation of the process of doping from others was recognized as indispensable. These two conditions have now been secured for doping the wings, but recent experience has shown that insufficient attention has been paid in some factories to the necessity of exhaust ventilation in *all processes in which tetrachlorethane dope is constantly used*. This applies especially to *taping*—now sometimes found carried on in the general erecting shop without any precautions—to which operation the three last fatal cases have been mainly due. Notwithstanding the comparatively small amount of dope used the close application required brings the face right into the fumes. And it is the same with the fuselage and other components—struts and landing gear. One attack was traced to the doping on one occasion of especially large wings in the general erecting shop because (it was alleged) the doping room proper could not accommodate them. There was a tendency in some premises before the great development of the industry was fully realized, to make the doping room too small. This should be avoided in future construction, but the risk involved by such a procedure as that described makes it incumbent on the occupier to improvise for any exceptional occasion a special exhaust system.

Pending the introduction of an efficient substitute for tetrachlorethane, it is most important that occupiers should (in addition to provision and maintenance of a high standard of exhaust ventilation)

consider and apply as far as they can the following further suggestions for safeguarding the health of the workers, which are the outcome of experience gained in various works.

(1) Exclusion of other work from the doping room.

The need for this has already been pointed out.

(2) Alternation of employment.

Considerable periods of overtime or long spells in doping or taping have been noted as having preceded some of the fatal attacks. Obviously, as poisoning is a matter of dosage, and the effect of tetrachlorethane is cumulative, the object aimed at by ventilation is defeated if hours of workers are prolonged beyond that for which the ventilation has been designed. In factories where alternation of employment has been arranged, *e. g.*, two days doping and two in other work, or one week in and one week out, improvement in health has resulted. And when such an arrangement is adopted occasional necessary overtime might, it is suggested, be undertaken by those on the out turn rather than by those who have already worked a full day in doping.

In addition to the alternation referred to, in one factory the women engaged in doping are made to spend half an hour morning and afternoon in the open air, so that no spell of work in contact with the fumes lasts longer than two hours.

(3) Periodic medical examination.

A fortnightly medical examination has served useful purpose, both in reassuring the workers and also in enabling those showing premonitory symptoms to be suspended or transferred to other work. The objective signs, however, which the surgeon has to guide him are few, and he can be materially assisted by information from the foreman or matron as to the state of health of the workers in the intervals between his examinations. After each visit the surgeon should state in writing the names of those (if any) whom he considers should be—

(a) suspended as definitely suffering from dope poisoning, necessitating absence from work until they are quite well, or

(b) transferred temporarily to other work as a precautionary measure on account of equivocal signs.

Medical supervision on these lines has been adopted on their own initiative or on suggestion from the factory department in several aeroplane works, and the same course should be pressed in all where doping is continuous. It is important that it should be carried out by a medical practitioner who is

familiar with the nature of the work and the symptoms to which it may give rise, preferably by the certifying surgeon, as he is in touch with the department and is thus kept informed of the latest observations on the subject. A health register and instructions as to the conduct of the examination will be sent by the medical inspector to the medical man whom you appoint for the purpose as soon as notice of his name is received here.

A worker suffering from effects of dope should be excluded from all contact with it until he is quite well, a medical certificate to that effect being obtained. Instances are known in which premature resumption led to recurrence of symptoms in an aggravated form.

Instruction to workers.—Certain apparently small points have been noticed which have a bearing on liability to attack. Some instruction to new workers as to how they can best avoid inhalation of fumes without interfering with work is called for, especially bearing in mind the youthfulness of some of them.

- (i) Doping should be commenced at the end of the wing nearest to the exhaust fans, and should proceed backward from that point.
- (ii) In some factories the wings, as soon as the doped surface is "tacky," are carried to a drying room or closed chamber (separately ventilated), thus diminishing largely risk from inhalation of fumes. Where no such arrangement exists, the wings should be placed to dry in a position between the workers and the exhaust draft, but not so as to obstruct the fans.
- (iii) After doping, the safest position for the worker is that nearest to the fresh-air inlets, but frequently men and women are seen standing close to the exhaust and therefore breathing the air which is most highly charged with the noxious vapor, the reason being that either the flat top of the outlet duct has been found a convenient place to keep dope pots, brushes, etc., or the light is better there than at the far side. Shortsightedness, unless corrected by glasses, should debar from taping if not from doping.
- (iv) Work should not be commenced on an empty stomach, and where tetrachlorethane is an ingredient of the dope a worker "must not be allowed to take a meal or to remain during the times allowed to him for meals in any room in which such substance is used." (Factory act,

1901, S. 75.) Hence the need for provision of a properly equipped meal room on lines suggested by the health of munition-workers committee.¹

Even if, as is hoped, discovery of an efficient substitute enables use of tetrachlorethane to be eliminated from the dope, exhaust ventilation will still be necessary to prevent the effects (fortunately much less noxious) from such solvents and diluents as benzene, acetone, and methylated spirit, which must necessarily continue to be used.

¹ Memorandum on industrial canteens, 1915, Cd. 8133, price 1d (2 cents).

92103°—Bull. 221—17—7

VENTILATION AND LIGHTING OF MUNITION FACTORIES AND WORKSHOPS.

[Memorandum No. 9.]

I.—INTRODUCTION.

1. At the present time a large number of new munition factories and workshops are being erected, altered, or enlarged. If the purpose of this extended provision is to be fully attained it is of the utmost importance that in the planning of the buildings everything possible should be done to secure that the work is carried on under the conditions most favorable to the maintenance of the health and physical energy of the workers. It must be borne in mind that however free the industry itself may be from unfavorable conditions, overtime and night work inevitably place a serious strain on the worker. The factory acts are concerned to secure in existing factories the minimum necessary in ordinary times, but present conditions and circumstances have brought into prominence problems which deserve special consideration in the building of new factories and the enlargement of old ones. The solution of these problems must largely depend on the particular circumstances of each case, and in the present memorandum the committee have set out certain considerations and suggestions, which they hope may prove of assistance to those immediately responsible for the satisfactory ventilation and heating of old factories, and for the planning of new factories and workshops.

II.—VENTILATION.

2. It has long been recognized that efficient ventilation of factories and workshops is essential for the maintenance of the health and comfort, and therefore of the efficiency and capacity, of the workers, and general regulations to secure this result are contained in the Factory Acts. The inquiries of the committee, however, have led them to believe that the attention paid to ventilation and to the closely associated problem of heating is in the majority of workshops insufficient; the ends to be aimed at are frequently misunderstood, and the means of securing them in consequence ill directed or altogether neglected. At the present time the importance of proper and effective methods of ventilation is often intensified not only by the

increase in number of workers, but by the continuous occupation of shops by day and night; there is under these conditions no interval in which natural ventilation can restore a vitiated atmosphere, and each shift succeeds to the bad conditions left by its predecessor.

3. The object which ventilation seeks to secure is twofold—namely, the removal of foul, exhausted or polluted air and the supply of fresh air in its place—that is, (1) air which is pure and clean for the workers to breathe, and (2) an atmosphere which is stimulating and refreshing. Air which is entirely pure from the chemical point of view may afford an atmosphere of a most depressing character which is highly detrimental to physical efficiency. It is not enough to aim only at clean air, as has been often customary in the past, or only at a stimulating atmosphere. In any consideration of ventilation both objects must be constantly in mind.

4. *Clean air*.—The impurities which are liable to be added to the air inside the workshop are—

- (i) *Carbonic acid*, given off in the breath of human beings and by fires, gas lights or any other form of open combustion. The increase in the amount of carbonic acid is accompanied by a parallel diminution in the oxygen of the air. The chemical changes produced in this way are not perceptible by the senses and there is no reason to suppose that they are, even under the most defective systems of ventilation to be found in factories, in any substantial degree harmful in themselves. Since, however, they are capable of easy and accurate measurement they are recognized as a useful index of the prevalence of more harmful impurities. It should not be assumed that a low percentage of CO_2 necessarily indicates a satisfactory atmosphere.
- (ii) *Various ill-defined volatile substances* arising from human beings, from the skin and the alimentary canal, especially when personal cleanliness is absent and sweating is profuse. The sum of these conditions gives the familiar “smell of humanity”; the substances are probably harmless in themselves, but they excite a feeling of discomfort in many persons and, in the more refined and cleanly individuals, one of disgust, which is detrimental to comfort and efficiency.
- (iii) *Bacteria* arising from human beings form a more definite and a more directly harmful sort of impurity. There is no doubt that the common catarrhal conditions (colds, sore throats, “influenza”) are for the most part spread from an infected individual to his neighbors by

organisms which are carried in the expired air with droplets of moisture especially during coughing and sneezing, though also during ordinary breathing and speaking. These diseases are often regarded as trivial in character; it appears likely, however, that if any correct estimate of lost time and diminished output owing to "colds" could be obtained, these would prove to be the most important infectious source of industrial inefficiency. Of diseases more serious as regards life as well as health, tuberculosis of the lungs is undoubtedly often disseminated in a like manner.

- (iv) *Industrial processes* give rise to a variety of impurities, dust, and fumes. Some of the most common of these impurities are injurious because they are unpleasant, e. g., the smell of hot oil, of various varnishes, and the like. Others are directly harmful, e. g., fumes from stoves, smoke, dust, etc., and a further group are of the nature of poisons, e. g., fumes of lead, of brass, or of tetrachlorethane. The last-named conditions occur only in exceptional cases, and their appropriate treatment presents problems of local ventilation which are special to each case (*see Appendix*¹). Reference should be made to the committee's Memorandum, No. 8, on "Special industrial diseases."

It is evident that the kinds of impurity present in any particular instance will vary widely with the prevalent conditions; a shop with a few clean men and many unhooded furnaces will present impurities chiefly of an inorganic kind, while many dirty men in a crowded machine shop will foul the air with organic impurity. Given normal conditions of personal and workshop cleanliness, the remedy is in all cases the same, and impurities of all kinds can be removed by an effective system of general ventilation which secures that the inside of the shop is well flushed with outside air. Small crowded shops evidently require more flushing with outside air than large sheds with a sparse population, and in very large and spacious shops the impurity of air may seldom reach a degree which is noticeably injurious.

5. *Simulating atmosphere.*²—The proposition which at first sight arises from these considerations is that a workshop may have so

¹ Page 107.

² Whether a workshop has an atmosphere which is satisfactory in this sense may generally be judged by the sensations, especially on first entering from the outside air. More accurate information may be obtained by the study of the particular way in which a "stuffy" atmosphere may be made "fresh." The ordinary thermometer measures the temperature of the air; the wet-bulb thermometer determines the humidity and gives an important measure of the facility with which the body can be cooled by sweating. These instruments, however, give only very imperfect data as to the cooling and skin-stimulating

large a cubic capacity in relation to the number of workpeople and the kind of process in operation that it does not require any definite ventilation. This is wholly false. In large shops there is a mass of stagnant atmosphere which is obviously depressing and relaxing, and fails entirely to provide the stimulating effect of cool air in gentle motion, which is provocative of the best physical and mental exertion. This exhilarating influence of atmosphere depends essentially upon the cooling of the skin by moving air, and it is necessarily closely connected with questions of temperature and heating. It is a matter of common experience that on the whole, cold air is more stimulating than warm, and is more conducive to physical effort. It is also within everyone's experience that damp warm air is more relaxing than dry air at the same temperature; the contrast between a rainy, windless, "stuffy," summer day and a day, perhaps actually far hotter, of blazing sunshine, with a brisk wind is familiar enough. Every-day observation further suggests that the relaxing effect of a warm, damp atmosphere is much reduced if moving air is brought to play on the body, e. g. by riding on the top of a bus, and that change of skin temperature is one of the essential features of what we call a fresh, pleasant air. These considerations are fully borne out by direct experimentation in the laboratory, and the desirable atmosphere is characterized by being:

- (a) Cool rather than hot;
- (b) Dry rather than damp;
- (c) Diverse in its temperature in different parts, and at different times, rather than uniform and monotonous; and (which is intimately connected with this diversity)
- (d) Moving rather than still.

The explanation of the familiar advantages of such an atmosphere seems to lie in the cooling and varying stimulation of the skin of

properties of any atmosphere, and it is necessary to have in addition some measure of the rate at which a warm body will lose heat.

In the observations made for the committee the rate of cooling has been investigated by means of the Kata thermometer (purchaseable from J. Hicks, 8, Hatton Garden, E. C.). A large bulbéd spirit thermometer (of standard size) is used; this is heated in hot water, and the rate of cooling measured by taking the time which the meniscus takes to drop from 100° F. to 95° F. while the instrument is suspended in the atmosphere. This gives the dry reading, and shows the rate of cooling due to radiation and convection. To take the wet reading the bulb of the Kata thermometer is covered with a damp muslin glove and the operation repeated, giving the rate of cooling when evaporation is added to radiation and convection. The rate of cooling at body temperature is recorded by means of a factor (determined for each Kata thermometer) in mille calories per square centimeter per second. The number of seconds occupied in the fall from 100° to 95° is divided into the factor.

In addition to the readings of the Kata thermometer those of the wet and dry bulb thermometer were taken. The records show how with the same wet and dry bulb readings, the rate of cooling may be strikingly different. The Kata thermometer, like the human body, notes the rate of change, while the thermometer notes a given state or the result of change. Thus the Kata thermometer takes count of the movement of the air and indicates conditions of comfort.

the exposed parts of the body. Putting the hands or the head under a cold-water tap removes most of the unpleasant sensations of being overheated, which follow violent exertion in hot damp air. The concentration of a current of air on too small a part of the body only causes what is generally known as a draught. It is a common experience that a slightly opened window causes a draught, whereas a widely opened window does not.

6. The close connection between temperature and the stimulating factors of an atmosphere renders it necessary to take also into consideration the question of warmth and cold in workshops. For a shop to be too hot is disadvantageous from every point of view, but the stimulation of too cold an air may be more than counterbalanced by the physical depression which results, and it is not difficult in cold weather for efficiency to deteriorate because the worker becomes uncomfortably chilled. It is hardly desirable to attempt any definition of the "best" temperature, since this must be subject to wide variations with the character of the work and the habit of the worker. It is evident that sedentary workers require a warmer atmosphere than those engaged in more violent labor, and attempts to obtain conditions satisfactory for both classes in the same shop will probably end in suiting neither. It may, however, be suggested that where the air is stagnant the temperature should not exceed about 60° F.; though it may be somewhat higher where the air is kept in motion.

The following examples are given in illustration of the results obtained. The first set of readings are for a bright pleasant day in May, and the other four are for typical shops as a contrast of types of "bad" and "good" shops. A comparison of the first, second, and third sets of readings shows that with the same temperature widely different rates of cooling may exist.

RATE OF COOLING AT BODY TEMPERATURE IN MILLECALORIES PER SQ. CM. PER SEC.

	Wet bulb.	Dry bulb.	Radiation, convection, evaporation.	Radiation, convection.	Evaporation.
(1) Bright, pleasant day in May, out of doors	60	68	27.2	7.5	19.7
(2) Brass foundry (good)	60	72	24	7.3	16.7
(3) Machine shop (bad)	61	72	15	4.6	10.4
(4) Cartridge annealing and cleaning (bad)	64.5	80.5	17.5	3.0	14.5
(5) Cartridge annealing and cleaning (good)	54.5	60.0	24.0	9.0	15.0

7. The problem of heating and ventilation will therefore appear in various forms according to the variations in local conditions—the cubic capacity and the shape of the workroom, the nature of work, the number of workers, the situation in relation to other buildings and hills and valleys, topographical position, season of year, climate,

etc. It is of the utmost importance that those responsible for planning the means of ventilation of any building should realize that each workshop provides a separate problem and that there is no uniform and stereotyped method which will give satisfactory results everywhere. It is impossible here to consider the innumerable combinations of circumstances which arise, but two broad groups may be mentioned.

- (a) A common case is where the air in the shop tends to be too hot or too stagnant, and, indeed, the observations of the committee would lead them to believe that this is one of the most frequent defects found in munition works. The production of heat depends in general on the same sources as those which produce carbonic acid and other impurities—human beings, lights, machinery, and furnaces. About four-fifths of the total energy expended by an active man appears in the form of heat,¹ and the friction of moving machinery also contributes. In sunny weather the “greenhouse effect” of a glass roof is an important factor. The atmosphere is further deteriorated by the moisture given off by the workers, and it may be by hot water used in some industrial process.
- (b) In cold weather, especially in shops where little heat is produced and the occupation is relatively sedentary, the problem is to maintain such a degree of ventilation as will keep the air pure and at the same time to have a comfortably warm atmosphere. This can be done only by the use of artificial heat. To shut off the ventilation and allow the shop to warm up with the heat naturally produced within it can not be too strongly condemned. Where possible it is better that additional clothing should be used. Heat produced by workers is always, and that arising from artificial lighting or processes of manufacture nearly always, accompanied by a proportionate quantity of impurities which are injurious and which must be got rid of. The human

¹ In sedentary occupations a still larger proportion appears as heat. Now an adult gives off from his body per hour about enough heat to raise 2,000 cubic feet of air from 60° to 70° F. Supposing that half of the heat is lost by radiation to walls and roofs, it would require the incoming of about 2,000 cubic feet of outside air at 50° F. per hour per man to keep the temperature from rising above 60° F. If the outside air were at 60° F., more than 20,000 cubic feet per hour per man would have to come in. Such extensive ventilation is a good deal more than would be requisite to maintain the air at a high degree of chemical purity, and under such circumstances the carbonic acid test for a satisfactory atmosphere is wholly fallacious. If, however, physical efficiency is to be maintained, the rise of temperature must be controlled. The exaggerated conditions prevailing in stokeholds of steamships have been successfully dealt with by the introduction of fresh air by means of a powerful fan.

impurities are especially objectionable since cold weather commonly coincides with the special prevalence of catarrhs and a special abundance of their causative bacteria. At the same time the ventilation required is clearly less than in hot weather, and it will suffice if clean air is obtained with such degree of movement and variability as will prevent it from being stagnant.

8. The means by which satisfactory natural ventilation is to be attained are, as has been already mentioned, subject to local considerations in every case, and general lines alone can be indicated here.

- (a) Local sources of impurity and heat production should be dealt with by the provision of hoods, exhausts, flues, etc.; smoke and fumes from neighboring workshops and chimneys may require attention. Workers should be so arranged in relation to each other that they do not cough and sneeze in one another's faces.
- (b) Definite openings communicating with the outside air should be provided in every workshop, and the committee would again emphasize the fact that the largest shop requires some system of ventilation. The form and nature of such openings can not be defined in a general way, but it appears to the committee that the average machine shop and all similar one-story shops should be provided with louvers along the roof ridges and in many cases also with narrow openings where the roof meets the walls. Such louvers should be permanently open, and will generally ensure that the atmosphere will at least not be grossly bad.
- (c) Such fixed openings do not, however, allow of the flexibility required to meet varying internal and external conditions, and should be supplemented by the use of doors, windows (which will open) and fans. Fans are especially valuable to meet emergencies and abnormal conditions, and provide for a thorough cleaning of the air during meal times.

III.—HEATING.

9. Means of heating are usually restricted by practical considerations to some system of steam or hot-water pipes. The ideal form is no doubt by radiant heat and the committee have found that rather old-fashioned stoves scattered about a shop may give good results and they have observed the excellent and invigorating conditions which prevail in many smithies and forges. Gas-heated radiators,

in which the burned gas escapes into the shop, are not permissible. The plan by which warmed air is pumped into the shop—commonly known as the “plenum system”—tends to create an atmosphere of a highly relaxing and depressing character. It affords a striking example of how chemically pure air may by its uniformity and monotony constitute an atmosphere in which good work is hardly possible. The means of ventilation should be kept separate from that of heating and the “plenum system” should only be used to pump in cool air in summer.

10. The most complete installation for ventilation and heating may be rendered ineffective by injudicious management or failure in proper and continuous maintenance. Rapid changes of climate, different times of day, varying circumstances of use and occupation, all require appropriate treatment. If, for example, the windows are shut because it is a cold morning there is a probability that they will usually not be opened again till the shop is much too hot. Such mismanagement is frequently due to the fact that it is the prescribed duty of no one in particular to observe the prevailing conditions and put in operation the appropriate appliances for the supply of air and heat. The committee are of opinion that the ventilation and heating of each shop or group of shops should be in the charge of some responsible person specially detailed for the purpose and they recognize that the effective maintenance of ventilation depends in large degree upon the vigilance of the workers. It is for the management to provide the means, it is for the employee to aid in their use and application. The effective maintenance of ventilation is becoming increasingly important owing to the large number of women now employed in munition works, since women are especially susceptible to the effect of defective ventilation.

11. The preceding paragraphs are primarily concerned with factories and workshops in which the nature of the work or the character of the material employed involve no special danger to the health of the worker. The serious problems of localized exhaust ventilation in shops where dust or poisonous fumes are evolved is the subject of a special memorandum (*see* Appendix) and the committee do not desire to add anything on the subject except to emphasize the extreme importance of taking all possible steps to protect the health of the workers.

IV.—LIGHTING.

12. This question has been treated with thoroughness and care in the Report of the Departmental Committee on Lighting in Factories and Workshops,¹ which has recently been published, and little more

¹ First Report of Departmental Committee on Lighting in Factories and Workshops, 1915 (Cd. 8,000).

is necessary than to refer briefly to the main conclusions of that report.

The essentials of good lighting are there summarized as:

- (a) Adequacy.
- (b) A reasonable degree of constancy and uniformity of illumination over the necessary area of work.
- (c) The placing or shading of lamps so that light from them does not fall directly on the eyes of an operator when engaged on his work or when looking horizontally across the workroom.
- (d) The placing of lights so as to avoid the casting of extraneous shadows on the work.

13. Natural lighting is to be preferred to artificial lighting on grounds of health as well as of economy. Where it can be arranged, roof lighting is generally to be preferred to lateral lighting. In a good system of roof lighting the illumination is very uniform. In modern factories where lateral lighting is employed a large part of the walls are devoted to windows, but it is evident that there is a limit to the width of the room, beyond which the illumination falls below what is adequate; what this width is will depend partly on the nature of the work to be done in the shop and partly on the extent to which the light is impeded by outside obstacles such as neighboring buildings or inside obstacles such as machinery.

14. The effect of light-colored walls and white ceilings on the general brightness of the room and in affording an effective background to dark objects should not be overlooked. In some cases the natural lighting may be improved by deflecting vertical light into the room by means of reflectors or prismatic glass or by whitening the surface of an external wall or building which obstructs the light. The position of permanent working points should be so adjusted in relation to the windows and to internal obstructions of whatever kind as to secure, so far as practicable, adequate daylight for each.

15. The necessity for the regular cleaning of windows on the inner and outer surfaces can not be too much insisted on. Not only do dirty windows prevent a large proportion of daylight from entering the shop, but the daylight period of work is considerably shortened and needless expenditure on artificial lighting incurred in consequence. At the present time the anti-air raid darkening regulations have much intensified this loss of natural light. In the construction of shops care should be taken to render the outsides of windows easily accessible for cleaning. In many existing shops access is so difficult as to make cleaning almost impossible.

16. The question of artificial lighting is of special importance at the present time when night work is general and when women and

boys are employed in large numbers. Bad lighting affects output unfavorably, not only by making good and rapid work more difficult, but by causing headaches and other effects of eyestrain; the difficulties of supervision, which are always considerable, are further increased if the general lighting of the workshops is insufficient.

A factory may be instanced where in one shop the ceiling was uniformly whitened and illuminated by arc lights which were shaded from the workers. The shop was illuminated by an agreeable diffuse light which cast no shadows. To produce the best effect the entire top surface can be covered with sheets of metal and enameled white. Such a method of lighting may prove to be more costly in upkeep, but it has compensatory advantages in promoting the health of the workers and thus may prove to be economical in the long run. In an adjoining shop the lighting was carried out by electric lamps, each suitably shaded to throw light down on the lathe and not on the eyes of the workers. In still another shop of the same factory fish-tail gas burners were in use, the lighting by such means being very poor and quite unshaded. Owing to the impoverished illuminating power of gas its use without incandescent mantles is to be condemned. Excellent lighting is obtained by the use of incandescent mantles and gas under pressure. The lamps in lofty shops can be placed high up so that they shed a diffuse light without directly throwing a glare into the workers' eyes.

17. Attention should be paid to the lighting of the passages and immediate surroundings of the factory as well as to that of the workshops themselves. In the report of the departmental committee, standards of lighting for factories are suggested, and though the figures given are the minima considered necessary, they may, at any rate, prove of assistance in suggesting the relative amount of light necessary in different parts of the factory.

Signed on behalf of the committee.

GEORGE NEWMAN, M. D.,
Chairman.

E. H. PELHAM, *Secretary.*
JANUARY, 1916.

APPENDIX.

LOCALIZED EXHAUST VENTILATION.

The essentials of localized exhaust ventilation are (a) a duct along which a flow of air is maintained in a definite direction and (b) a localized opening or openings in this duct through which sufficient air is admitted to allow the flow of air to be maintained. The air so admitted carries with it any dust or fumes the removal of which is desired; and this action may be made effective for the purpose of removing from the atmosphere of work places of (1) dust, (2) heated fumes such as arise from melting scrap lead and other poisonous materials, or (3) volatile vapors such as are evolved when dope varnish evaporates. The principles underlying effective action differ for each of these purposes.

1. The removal of dust is best effected by an air current produced by mechanical power, preferably by a pressure fan, and so arranged as to prevent the dust particles escaping from the place where they are produced into the general atmosphere. For this purpose the openings in the ducts should termi-

nate in hoods shaped so as to envelop, as far as practical, the seat of origin of the dust. In the case of dust from a revolving wheel, the hood and duct should be placed to intercept the dust which is thrown tangentially from the wheel and to catch dust which would otherwise fall to the ground; the dust then comes under the influence of the air current in the hood and is drawn into the duct, while the air current itself is assisted by the air thrown off by the wheel. Where dust is created by manual labor, the operative should stand or sit facing the opening of the hood, so that the current of air draws the dust away from him.

2. The removal of heated fumes may usually be effected without using mechanical power, but to attain this end the duct should be vertical, of ample diameter and height, and surmounted by a suitable wind cowl, while the lower end should open gradually into a bell-mouthed hood. The lower end of the hood should envelop and extend below the place where the heated fumes originate. The opening to the hood should only be large enough to permit of necessary manipulations. The errors usually found in this form of exhaust ventilation are (i) the opening to the hood may be too large, and air currents in the work place carry the fumes away before they come under the influence of the draft; (ii) owing to the sides of the hood too nearly approaching the horizontal, the area within the hood may be too small; (iii) the height of the upcast shaft or vertical duct may be insufficient; and (iv) provision may not be made to avoid down draft due to wind.

3. Volatile vapors such as those given off when aeroplane wings are varnished are difficult to localize. If, as is usually the case when noxious vapors have to be dealt with, the vapor is heavier than air, the openings to the duct must be at the ground level and as near as practicable to the place where the vapor is given off. The air current must be so arranged that large volumes of air are drawn away, and ample openings for incoming air must be arranged high up in the workroom.

A factor essential to any form of localized exhaust ventilation is the distribution and size of openings for incoming air in the workroom generally. To obtain an interchange of air and so secure general ventilation, these openings should be placed as far as possible from the exhaust openings, preferably on the opposite side of the workroom; and to avoid drafts, such openings should comprise an area three times that of the exhaust openings. The supply of incoming air may, in some cases, be insured by the use of a pressure fan driving in air through well-distributed openings.

In practice the efficiency of exhaust plants is frequently found impaired by lack of attention to details: (i) The hood to collect dust may be too small, in which case dust flying from a wheel is not intercepted; (ii) the shape of the hoods may be faulty, in which case dust accumulates on areas having an inclination toward the throat less than the angle of rest of the dust, or, in the case of heated fumes, the expanding gases rebound and escape from the hood like smoke from a badly constructed domestic chimney; (iii) the duct opening may be so small that dust collects there and blocks the opening; (iv) the inlets to the work place may be insufficient to admit freely the amount of air required, in which case the air flow in the ducts is slowed, and if a fan is being used power is wasted in driving the fan; (v) bends in the ducts if too sharp impede the flow of air; (vi) where dust is being dealt with, dust-settling chambers of insufficient size or with insufficient openings may have been provided; (vii) insufficient attention may have been paid to the plant erected; hoods detached from ducts, holes broken into ducts, and ducts blocked with every kind of débris have

been found in well-planned installations and in places where considerable power is being expended to drive exhaust fans.

Generally speaking, where a keen draft, as for the removal of dust, is required, pressure fans should be employed; since these fans, though requiring more power to drive, can work against considerable pressure, smaller ducts may be used. Where, on the other hand, large volumes of air are to be removed, volume fans can be more economically employed; but with such fans attention to the sectional area of the ducts is of great importance; the ducts must never be constricted at any point; the total area of the openings must be greater than that of the fan, and all sharp bends in the ducts must be avoided; further, the delivery side of the fan must not be impeded or so placed as to be exposed to the action of wind.

Nearly every work place where localized exhaust ventilation is required presents special problems of its own, for the solving of which technical advice may be necessary, but adherence to the principles above enumerated will effect great improvement. In particular, wherever an exhaust system has been installed the duty should be placed on some responsible person of testing and reporting to the management at stated intervals on the efficiency and maintenance of the installation.

THE EFFECT OF INDUSTRIAL CONDITIONS UPON EYE-SIGHT.

[Memorandum No. 15.]

1. The committee have found it necessary to give special attention to the effect of munition work on the eyesight of the workers. As a result of their inquiries they have received numerous communications from various authorities and individuals interested in this important matter. Speaking generally, there has been a considerable increase at the hospitals in the number of eye cases among munition workers, partly due to the increase in the number of such workers and partly due to their inexperience of metal and engineering works. The result has been not only personal suffering and inconvenience, but also a serious loss of time and a reduction of output. It must be remembered that the eyes are among the hardest worked of all the organs of the body, and that they are extremely sensitive to external conditions. It is, therefore, not surprising that a number of special eye diseases and injuries from accidents to the eyes have come to be associated with the particular processes of certain industries. Yet many of these diseases and injuries are preventable. A few instances communicated to the committee may be quoted.

About 15,000 cases of eye injuries are seen annually at the Birmingham Eye Hospital, and about 1,500 at the Coventry Hospital. The majority of the cases are slight, but even in these at a conservative estimate the loss of time to each man averages half a day; that is to say, that in one district alone from 500 to 700 days' work are lost annually from these trivial accidents.

At the present time at the Moorfields Eye Hospital there are probably not less than 20 men per diem from engineering shops who come to have small foreign objects, usually metal or emery, removed from the eye. A large proportion of these cases come from munition and armament factories, say in all 100 per week. Each man will lose not less than three days from this, in most cases, preventable accident, representing 300 days' work, or, say 40 men idle per week from this cause.

At the Royal Eye Hospital, Manchester, "it is estimated that small chip-pings of metal in the eye cause absence from work on an average for three days, and more serious cases would probably average ten days."

At the Northumberland, Durham and Newcastle Eye Infirmary there has been an increase in the number of patients in 1914 and 1915, and this is largely due to the number of people engaged on munition

work. For example, in 1914, 2,491 eye cases were referred for treatment from the Elswick Works; in 1915 there were 4,973 similar cases.

Lastly, at the Royal Eye Hospital, London, it is stated that "a large and increasing number of munition workers are being treated daily in the casualty department, chiefly for slight accidents, foreign bodies, etc. We have not hitherto kept a special record of munition workers, but I am assured by the nurses that they number from one-half to two-thirds of the cases treated."

The following letter from one of the honorary surgeons of the Wolverhampton Eye Infirmary illustrates the nature of the problems under review:

The number and character of the cases dealt with at the Wolverhampton Eye Infirmary has not been appreciably affected by the extension of munition work, the number of out-patients having increased by a small number only; out-patients in 1913, 8,491; in 1915, 8,544. The number of foreign bodies impacted has increased; 1913, 2,796; 1915, 3,083; but this is due to the workers coming for skilled removal and not trusting their fellow workers to remove them as they did formerly. There has been no increase in eye diseases, and it is impossible to say whether eyestrain has increased or not, the number of cases treated being practically the same in 1913 and 1915. The chief causes of eye injury in engineering and other munition areas are due to impacted and other perforating bodies, lathe work and grinding being the most prolific in producing them. There is a slight increase in infective traumatic ulcers, but this is not sufficient to cause comment. Workers being chiefly troubled by having foreign bodies impacted are usually away from work until they have had them removed, and the average time in these cases would be half a day; the more serious cases would average about two to three weeks.

There have been no difficulties in regard to treatment. The wearing of goggles, though objected to by the workers, has for a long time been urged by the medical staff as a protection against injury. A few cases have been seen lately of acute conjunctivitis due to chemical irritation, but they have quickly recovered when the workers kept away for a few days. A pair of close-fitting goggles like those worn by motorists would be a great protection in these cases where irritating chemical gases are in evidence.

2. Industrial work may cause impairment of eyesight in three chief ways:

- (a) Injuries due to exposure to intense heat or industrial poisons.
- (b) Accidents due to flying particles, etc.
- (c) Eyestrain due to uncorrected errors of refraction or other causes.

3. *Effect of intense heat, etc.*—The effect exerted upon the eyesight by certain industrial poisons used in munition works, such as lead, is in the bulk small, and the influence of prolonged exposure to intense heat and light may take so long a period to manifest itself

(e. g., glassmakers' and furnace workers' cataract) that the damage which may result is not likely to appear during the period of the war. These two occupational influences upon eyesight, therefore, hardly call for consideration here, nor is it within our province to deal with the serious eye injuries which occur among stonemasons, miners, etc. The immediately irritative effect associated with such work as acetylene welding will be referred to later.

4. *Accidents*.—It has been estimated that in normal times in any general group of industrial accidents, over 5 per cent must be ascribed to eye injuries, and that on this basis in 1913 over 8,000 more or less severe eye injuries occurred in the factories of the United Kingdom. The views expressed by ophthalmic surgeons and others indicate that eye injuries in munition work are relatively more frequent than in normal times, and that for engineering factories these cases probably represent about 7 per cent of all accidents, a total which may, however, be greatly exceeded and even reach 20 per cent. Authorities are unanimous in considering that such accidents are largely preventable.

An important trades-union association has stated that, although the percentage (nearly 7 per cent) of eye injuries to the total number of accidents is not appreciably greater than before the war, yet the total number of accidents for this year (1916) to date is nearly 50 per cent greater than for the corresponding period last year, and the suggestion is made that a greater number of slight eye injuries are resulting because the major portion of munition work, so far as machinery is concerned, is lathe-turning, when the turnings break or fly off, striking the operator.

From the reports sent to the committee by hospital surgeons it appears that accidents are mainly due to particles of metal which enter the eye; that the majority of these accidents are slight in character and should give rise to no permanent damage, but that there is a certain proportion of serious accidents which cause permanent injury. "The causes of eye injury are due largely, if not mainly, to the bursting of emery wheels, steel splinters, etc.," says the report of an eye hospital at Liverpool, which records that between three and four times as many cases per annum have been treated since the war began. To the damage which results from injuries sufficiently serious to come under observation and be included in statistical inquiries must be added the much more grave conditions arising from infection following upon "fires" or other trivial eye injuries. Account must also be taken of the time lost and temporary inconvenience suffered from a much larger number of slight causes which may only incapacitate the sufferer for short periods, perhaps half a day. In so far as immediate reduction of output is concerned, these slight cases have probably a greater effect than the more serious injuries.

Speaking of these cases, an ophthalmic surgeon in Glasgow writes: "In most instances the actual physical damage is slight, and the worker will be able to resume his duties in a few hours, or utmost in one or two days, if only the injury to the eye be promptly and skillfully treated. If, on the other hand, the injury be neglected or if it be treated by anyone who is unskillful or careless, sepsis will almost certainly occur; and all experience teaches that infection of the wound is a far greater danger than the actual physical damage to the ocular structures. The occurrence of sepsis at once transforms a very trivial injury to the cornea into a suppurative keratitis, which may run a prolonged course, lead to more or less impairment of sight, and in serious cases even destroy the eye."

5. *Eyestrain*.—Broadly speaking, this may be due to defects of vision or to the nature or conditions of the work. It may be accentuated by the age, fatigue, or unsatisfactory physical health of the worker, by near distance work, insufficient or excessive illumination, abnormal position, or long hours. Operators employed on munition work should possess and maintain a certain standard of visual acuity if they are to perform satisfactorily the work expected of them. This standard, though it may vary for different processes, should never fall much below that of normal useful vision. For fine work the eyesight should be approximately normal. Notwithstanding the important bearing which good eyesight must have upon output, the question is not to-day receiving adequate attention at the hands of those whose duty it is to obtain this output. Instances have come under the notice of the committee of headaches and eyestrain resulting from (a) inadequate light, both artificial and natural; (b) artificial lights adequate in amount but so placed as to throw a glare on the eyes of the workers; and (c) employment of workers (whose eyesight should be aided by suitable glasses) to carry out fine work without first testing their eyesight. Eyestrain, including headache, may be one manifestation of general fatigue. It is thus likely to become more marked when long hours are worked, when night shifts are necessary, or when workers are undernourished, anemic, or of poor general physique.

6. The lighting of factories has so recently been dealt with in detail in the report of the committee on lighting in factories and workshops that no further reference is here needed. But the question of supervision of the eyesight of workers employed on fine work calls for special comment. At one factory where a medical investigation of women workers was carried out on behalf of the committee, the reporter states that "although the general conditions of employment are satisfactory and the management has given considerable thought to the comfort of the employees, in one process which involved fine

work, out of seven girls one suffered from severe, and the other six from occasional, frontal headache attributable to eyestrain. One girl wore glasses obtained from an optician nine years previously. It would be an advantage if all girls before being employed on this process had their eyes medically examined." From another factory it is reported that "in contrasting the eye conditions found in the different workshops the worst effects were found in the fuse department, where the fine process involved close attention. Here 8 per cent of the workers had been obliged to obtain glasses since starting the work, 12 per cent found sight difficult at night, another 7 per cent complained of eyestrain, and 2 per cent found eyestrain increasing in severity. Besides these, 10 per cent appeared to have latent eyestrain, as shown by severe eyestrain and conjunctivitis, and they should have their eyes tested." Another medical reporter remarks that "great carelessness was displayed among those whose ocular defects required attention. Repeatedly I called attention to the necessity of having these adjusted and arranged with the managers to allow individuals so affected leave of absence, but no advantage was taken of the opportunity." The diseased conditions arising from eyestrain or accidents are numerous and include not only the presence of foreign bodies, metal dust, or steel splinters in the eye, but various forms and degrees of inflammation, ulceration, myopia, astigmatism, and visual deterioration.

PREVENTION AND TREATMENT.

7. Many conditions likely to cause temporary or permanent damage to the eyesight of munition workers are admittedly preventable, while the prompt and effective treatment of the injury when it has occurred will reduce suffering, hasten recovery and lessen the chance of permanent injury. The following letter received by the committee is of interest in this connection:

Of recent months the great increase in the numbers of those attending the eye department of the Glasgow Royal Infirmary suffering from injury to the eye has been very noticeable. For the most part the injuries have been trivial and due to foreign bodies, but there have also been cases of penetrating wounds; the latter, however, have been few in comparison with the marked increase in the number of patients applying at the out-patient department on account of slight accidents or diseases.

If such ailments are attended to promptly they ought to heal rapidly and leave no trace. The workman, therefore, ought not to be off duty for more than a few days, but if on the other hand infection of the wound has occurred before he seeks skilled help, he may be absent from work for several weeks. It is, in the great majority of cases, the subsequent infection of the wound rather than the actual physical injury that is most to be dreaded, and the fate of an injured eye depends upon the treatment it receives within the first few hours following the accident.

Most of these accidents would be prevented if the workman would wear suitable protective glasses, and disastrous results would be very few if the workman understood that he ought to report every injury to the eye, no matter how trivial, immediately on its occurrence, and if arrangements were made whereby he could receive expert medical assistance as speedily as possible. These conditions might easily be fulfilled if the nurse in attendance at the munition works was instructed to send all patients suffering from injury to the eye direct to an ophthalmic clinic and never attempt to do more in these cases than give first aid.

8. *Methods of prevention* consist, first, of general measures designed to improve the physical health of the workers and so enable them to resist the effects of fatigue and, secondly, of special measures intended to avoid undue strain on the eyesight or to reduce the liability to accident to a minimum.

General measures, such as the suitable lighting of factories, the provision of canteens, adequate time for sleep and rest, have been dealt with in other memoranda and need no further reference here. Special arrangements necessarily vary in different cases and should be under the general supervision of the medical officer of the factory. The following suggestions are made:

9. *Examination of eyesight*.—When operatives are being engaged for fine work which calls for close attention, the eyesight of each should be tested by the medical officer, or, if he is not available, the nurse or welfare supervisor should apply simple eye tests¹ for the purpose of discovering those whose vision is not normal. All who fail to reach the standard adopted should be sent to the medical officer or to an ophthalmic surgeon or eye hospital to be fully examined and, if necessary, supplied with glasses. When workers are examined for glasses the nature of the work to be performed should be specified whenever possible. In many people and particularly those past middle life, the glasses which give the best acuteness of distant vision would not enable the owner also to do fine work at short range and vice versa. Workers who complain of frequent headache, pain in the eyes, or show signs of conjunctivitis should also be tested in this way.

10. *Eye guards and goggles*.—Under certain conditions the eyes should always be guarded from flying particles of metal. To be effective, an eye guard—

- (a) Should prevent particles reaching the eyes from in front, from either side or from below. Practically nothing enters from above.

¹ Each eye should be tested separately, and the following standard is suggested as a minimum: 6/9 in both eyes (Snellen's types), though 6/12 in one of the eyes may be sufficient in some cases; and the ability to read standard type 0.45 at 1 foot distance. The necessary standard types can be procured from any optician.

- (b) Should be light and comfortable, and allow free play of air so that moisture does not condense on the transparent medium.
- (c) Should not impede vision, or become obscured by the impact of particles.
- (d) Should be strong and cheap.

The fact that no particles are likely to enter from above is important, because the upper part of the goggle may be left open and so allow of ventilation. A closed screen not only becomes hot and uncomfortable, but the transparent medium, usually glass, may be obscured by condensation of moisture. Where fine work has to be executed, there must be clear vision, and for this purpose no medium is better than glass. The objection has been raised that glass broken by a flying particle may be driven into the eye and cause a worse injury than if it were not present. It is stated, however, that "injuries to eyes by glasses or spectacles broken by a foreign body are very rare. It is a very exceptional accident, and a considerable sized foreign body would be necessary to inflict it, and the damage to the eye would probably not be less if no spectacles or protecting glass were in use. Glass such as is used for shooting goggles, of sufficient strength to withstand the impact of pellets of shot, should be employed." An American shop bulletin states that "in no instance was an eye even slightly injured by flying glass where the lens was broken by a flying chip." The main objection to glass, or indeed to any other transparent medium, is that after a time it becomes pitted and obscured. For this reason eye guards should be so made that the glass can be easily removed and cleaned or replaced.

Two forms of eye guard have been designed to meet the requirements stated above. One has the advantage that spectacles required to correct any error of refraction can be worn behind it. The other is composed of a strip of leather with detachable eyepieces pierced with holes for ventilation.

At one factory it has been found possible almost to eliminate accidents due to flying nails, which are particularly serious, by corrugating or scoring the heads of the hammers used.

Where there is exposure to bright light, as in the process of acetylene welding, the glass of the goggles should be tinted or specially prepared to obscure the chemically active rays at or beyond the violet end of the spectrum, otherwise troublesome irritation and conjunctivitis result. Dark-blue glass is usually employed for this purpose.

11. *Treatment of accidents.*—First-aid treatment is all that can be rendered effectively in the factory, but as the subsequent history of the case depends so largely on the way in which first aid is applied every precaution should be taken to avoid increasing the injury by well-meant but misdirected efforts to give relief. Many factories

are now provided with ambulance stations or surgeries, and where this is the case all eye injuries should be sent direct to the surgery, no treatment being attempted in the workshop. If a doctor is on the premises, the case should be referred to him at once. If the injury is not serious, and he is not available, the nurse in charge of the surgery should render first aid and subsequently refer the patient to his own doctor or a hospital. It is most desirable that even apparently slight injuries should be seen by a doctor. At any factory where eye injuries are common the nurse should have had some ophthalmic training.

12. If there is no ambulance station or nurse, first aid can only be given by a fellow workman who should be instructed as to the routine treatment which may suitably be applied. He should be forbidden to exceed these instructions in any way, otherwise, though he may be successful in removing an offending particle, infected ulcers may follow the operation or he may even perforate the cornea. First aid is mainly needed to relieve pain, and should as a rule be limited either to the use of eye drops¹ which may be applied from a suitable bottle, or to a pad and bandage. A camel's hair brush kept in the appropriate solution may be provided for the removal of visible particles which are not impacted or embedded, but its use should not be encouraged. After relief from pain the patient should be sent at once to a doctor or a hospital.

GEORGE NEWMAN, M. D.,
Chairman.

E. H. PELHAM, *Secretary.*
OCTOBER, 1916.

¹ A leaflet issued in 1915 by the Home Office contains information on this point.

TREASURY AGREEMENT AS TO TRADE-UNION RULES AFFECTING RESTRICTION OF OUTPUT—CONFERENCE AT THE BRITISH TREASURY, MARCH 17, 18, AND 19, 1915.

In opening the conference proceedings, the chancellor of the exchequer made the following statement:¹

"You know that the position is a serious one. You know it by the speech delivered by Lord Kitchener in the House of Lords, I think on Monday last. In every country engaged in the war they have discovered that the expenditure of war material is considerably in excess of any anticipation ever made by the general staff; so that, even in the best-prepared countries, the pressure is beyond anything that anyone ever expected.

"I have no doubt you have read the account of the battle which took place last week, which gives you a very good idea of what the increase in the output of munitions means, not merely from the point of view of success, but from the point of view of the lives which you save if an army is well equipped. The position for the attack was prepared by the most tremendous concentration of artillery fire that has probably been witnessed upon any given point during the whole of this war.

"What was the effect of that? It was not merely to insure success, but, what was equally important, its effect was to save the lives of British soldiers in the attack that was made. The French told me in France when I was there that by a concentration of fire upon a particular point they were able to achieve their purpose with one-tenth of the loss of life which they otherwise would have needed to accomplish that object.

"That is why it is not merely urgent that we should get an increased output; it is urgent that we should accelerate it. Every month that there is delay in the output may mean two or three months added to the duration of the war, with all its horrors.

"The Government have, therefore, decided to take action—absolutely unprecedented action—in organizing the industries of this country for the purpose of increasing the output, in order to give support to our gallant countrymen when they advance to the attack against the enemy.

¹ Trades-Union Congress, Forty-seventh Annual Report, 1915, p. 220 et seq.

"What does it mean? I do not want to use the term 'taking over' without explaining that it is capable of an interpretation which I do not wish to put upon it.

"By taking over a works we do not mean to establish an admiral or a general in command of the works, turning adrift those who are managing them at the present moment; that is an impossible task.

"We mean to assume control of works which are now being exclusively devoted to that purpose. There are certain works which are not adapted for that kind of control, but there are others which are, and the great works which are now being used for the purpose of the production of munitions of war are eminently works of that kind.

"Above all, we propose to impose a limitation of profits, because we can quite see that it is very difficult for us to appeal to labor to relax restrictions and to put out the whole of its strength unless some condition of this kind is imposed.

"The workmen of the country, I am perfectly certain, are prepared to put their whole strength into helping the war, so long as they know that it is the State that is getting the benefit of it, and that it does not merely inure to the profit of any particular individual or class.

"If we are merely to take over the works and assume control and guarantee profits within that limit, you will realize that means that the employer has not quite the same interest as he has now in limiting expenditure. Therefore we might be face to face not merely with the employees making demands upon the State which we for the moment might regard as unreasonable, but we might find the employers in combination with them, and therefore we should have employers and employed combining to bring pressure upon the State, and we should not be in a position to deal with it unless we had a complete understanding in advance.

"That is exactly what we want. Before we undertake the control and direction of these works, and undertake the responsibility for them, we must have a complete understanding with the employers and employed.

"What understanding can be asked for? The understanding we must get with the employers is an understanding with regard to the limitation of profits; that we must get, and an understanding, of course, that whatever the State wants done there shall be done. I do not dwell upon those two points; those are matters which I shall have to put before the employers when the time comes, but these are the points I wish to put before the representatives of the workmen.

"For the moment we are liable to have important work interrupted by labor disputes. As I have said before, it is not a question of who is to blame there. The question is, How is the interruption

of work to be prevented while you are settling the dispute? That is the matter which it is important to us to consider.

"Speaking on behalf of the Government, we do not say that the workmen ought never to complain, or that the workmen ought never to ask for an increase of wages; that is not our point. Our point is that during the time the questions at issue are being adjudicated upon the work shall go on.

"The first proposition, therefore, which I shall put before you for your consideration is this: 'With a view to preventing loss of production caused by disputes between employers and workpeople, no stoppage of work by strike or lockout should take place on work for Government purposes.

"In the event of difficulties arising which fail to be settled by the parties directly concerned, or by their representatives, or under any existing agreement, the matter shall be referred to an impartial tribunal nominated by His Majesty's Government for immediate investigation and report to the Government with a view to a settlement.' All this is purely during the continuation of the war, and does not bear on anything that might happen after war.

"There are three suggestions which I put forward for the settlement of disputes. The first is that a single arbitrator, agreed upon by the parties or appointed by the Board of Trade, should adjudicate—that is the first one.

"The second one is the committee on production. I think that consists of Sir George Askwith, Sir Francis Hopwood, and Sir George Gibb. The third proposition is that a court of arbitration shall be set up, upon which labor is represented equally with the employers. Those are the three methods I put before you for your consideration.

"That is my first proposition. I should like, on behalf of the Government, to establish an understanding with labor that in works which are turning out munitions and equipments for the war, where there is a dispute occurring, there shall be no dropping of tools, but that some means shall be established by which the dispute shall be settled without any interruption of the work.

"The second point is a very difficult and a very delicate one to handle, as I know. I am very glad at this point to be able to give you good news from the Clyde. There are some of you here who know it, but there are others who, perhaps, have not heard it. I believe there has been a ballot on the Clyde, which began about a week ago, and I understand that although the ballot is scarcely completed the result is overwhelmingly in favor of accepting the Government's proposals for arbitration in the matter.

"The second proposition is the suspension, where necessary during the war, of restrictions of output. Here again I want to make it

perfectly clear that I am only discussing this suspension during the war.

"There is the question of the number of machines which one man is permitted to attend to; there is the question of the employment of semiskilled labor, where under normal conditions you could not assent to it; and there is the question of the employment of female labor.

"In France there is a vast amount of work being done by women and by girls in the ammunition factories. In that country they have suspended all these rules and regulations for the time being, because they realize that the security of their country depends upon it.

"There are two alternatives before this country, and they are alternatives which must be presented to every class here. At the end of this war we shall either be the vassals of the German military caste (drunk with success) or we shall have broken militarism forever.

"It is because I realize as a democrat how very important that is, that I am making this appeal to the leaders of the workmen to assist us to organize our industries.

"The president of the Board of Trade and myself will make exactly the same appeal to the employers—that it is important for us to mobilize to the last the whole of our resources, so that we shall be able as a nation, perfectly united, to march to a victory which is essential, I can assure, to human liberty."

The following trade-union representatives were appointed by and from the conference to act as an advisory committee to assist in drafting the proposed scheme: Messrs. A. Henderson, M. P., J. T. Brownlie (engineers), A. Wilkie, M. P. (shipwrights), J. Hill (boilermakers), W. Mosses (patternmakers), F. Smith (cabinet-makers), and C. W. Bowerman, M. P. (Parliamentary Committee Trades-Union Congress).

PROPOSALS AGREED UPON AS RESULT OF THE CONFERENCE.

I.

During the war period there shall in no case be any stoppage of work upon munitions and equipments of war or other work required for a satisfactory completion of the war.

All differences on wages or conditions of employment arising out of the war shall be dealt with without stoppage in accordance with Paragraph II.

Questions not arising out of the war should not be made the cause of stoppage during the war period.

II.

Subject to any existing agreements or methods now prevailing for the settlement of disputes, differences of a purely individual or local character shall, unless mutually arranged, be the subject of a deputation to the firm

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representing the workmen concerned; and differences of a general character affecting wages and conditions of employment arising out of the war shall be the subject of conferences between the parties.

In all cases of failure to reach a settlement of disputes by the parties directly concerned, or their representatives, or under existing agreements, the matter in dispute shall be dealt with under any one of the three following alternatives as may be mutually agreed, or, in default of agreement, settled by the board of trade:

- (a) The committee on production.
- (b) A single arbitrator agreed upon by the parties or appointed by the board of trade.
- (c) A court of arbitration upon which labor is represented equally with the employers.

III.

An advisory committee representative of the organized workers engaged in production for Government requirements shall be appointed by the Government for the purpose of facilitating the carrying out of these recommendations and for consultation by the Government or by the workmen concerned.

IV.

Provided that the conditions set out in Paragraph V are accepted by the Government as applicable to all contracts for the execution of war munitions and equipments, the workmen's representatives at the conference are of opinion that during the war period the relaxation of the present trade practices is imperative, and that each union be recommended to take into favorable consideration such changes in working conditions or trade customs as may be necessary with a view to accelerating the output of war munitions or equipments.

V.

The recommendations contained in Paragraph IV are conditional on the Government requiring all contractors and subcontractors engaged on munitions and equipments of war or other work required for the satisfactory completion of the war to give an undertaking to the following effect:

Any departure during the war from the practice ruling in our workshops, shipyards, and other industries prior to the war, shall only be for the period of the war.

No change in practice made during the war shall be allowed to prejudice the position of the workpeople in our employment or of their trade-unions in regard to the resumption and maintenance after the war of any rules or customs existing prior to the war.

In any readjustment of staff which may have to be effected after the war, priority of employment will be given to workmen in our employment at the beginning of the war who are serving with the colors, or who are now in our employment.

Where the custom of a shop is changed during the war by the introduction of semiskilled men to perform work hitherto performed by a class of workmen of higher skill, the rates paid shall be the usual rates of the district for that class of work.

The relaxation of existing demarcation restrictions or admission of semi-skilled or female labor shall not affect adversely the rates customarily paid for the job. In cases where men who ordinarily do the work are adversely

affected thereby the necessary readjustments shall be made so that they can maintain their previous earnings.

A record of the nature of the departure from the conditions prevailing before the date of this undertaking shall be kept, and shall be open for inspection by the authorized representative of the Government.

Due notice shall be given to the workmen concerned, wherever practicable, of any changes of working conditions which it is desired to introduce as the result of this arrangement, and opportunity of local consultation with men or their representatives shall be given if desired.

All differences with our workmen engaged on Government work arising out of changes so introduced, or with regard to wages or conditions of employment arising out of the war, shall be settled without stoppage of work, in accordance with the procedure laid down in Paragraph II.

It is clearly understood that, except as expressly provided in the fourth paragraph of Clause V, nothing in this undertaking is to prejudice the position of employers and employees after the war.

D. LLOYD GEORGE.

WALTER RUNCIMAN.

ARTHUR HENDERSON,

Chairman of Workmen's Representatives.

WM. MOSSES,

Secretary of Workmen's Representatives.

TRADE-UNIONS REPRESENTED AT THE CONFERENCE.

Friendly Society of Iron Founders.
British Steel Smelters' Association.
Amalgamated Society of Engineers.
Federation of Engineering and Shipbuilding Trades.
National Transport Workers' Federation.
General Union of Textile Workers.
Amalgamated Society of Carpenters and Joiners.
Boilermakers and Iron and Steel Shipbuilders' Society.
Ship Constructors and Shipwrights' Association.
National Amalgamated Sheet Metal Workers.
United Operative Plumbers' Association.
Gasworkers and General Laborers' Union.
General Union of Carpenters and Joiners.
United Patternmakers' Association.
National Amalgamated Furnishing Trades Association.
National Amalgamated House and Ship Painters and Decorators.

National Union of Railwaymen.
Parliamentary Committee Trades-Union Congress.
Boot and Shoe Operatives' Society.
United Machine Workers' Association.
Associated Iron and Steel Workers of Great Britain.
National Amalgamated Union of Labor.
The Workers' Union.
Amalgamated Toolmakers.
Shipbuilding Trades Agreement Committee.
General Federation of Trade-Unions.
Electrical Trades-Union.
Associated Blacksmiths and Iron Workers.
Associated Ironmolders of Scotland.
National Amalgamated Cabinetmakers.
Steam Engine Makers' Society.
General Union of Braziers and Sheet Metal Workers.
Scottish Painters' Society.
Sheet Iron Workers and Light Platers' Society.
National Brass Workers.

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The invitation to your committee¹ to be represented at the Treasury Conference was in the following terms:

BOARD OF TRADE,

7, Whitehall Gardens, London, S. W., March 12, 1915.

SIR: I am directed by the Board of Trade to invite the parliamentary committee of the Trades-Union Congress to send three representatives to a conference at the Treasury on Wednesday, March 17, at 11 a. m., to consult with the chancellor of the exchequer and the president of the Board of Trade on certain matters of importance to labor arising out of the recent decision of the Government embodied in the Defense of the Realm (Amendment) Act, to take further steps to organize the resources of the country to meet naval and military requirements.

I am, sir, your obedient servant,

H. LLEWELLYN SMITH.

The SECRETARY, TRADES-UNION CONGRESS PARLIAMENTARY COMMITTEE.

MUNITIONS OF WAR ACT (JULY 2, 1915).

PART I.

SETTLEMENT OF LABOR DIFFERENCES.

1.—(1) If any difference exists or is apprehended between any employer and persons employed, or between any two or more classes of persons employed, and the difference is one to which this part of this act applies, that difference, if not determined by the parties directly concerned or their representatives or under existing agreements, may be reported to the Board of Trade, by or on behalf of either party to the difference, and the decision of the Board of Trade as to whether a difference has been so reported to them or not, and as to the time at which a difference has been so reported, shall be conclusive for all purposes.

(2) The Board of Trade shall consider any difference so reported and take any steps which seem to them expedient to promote a settlement of the difference, and, in any case in which they think fit, may refer the matter for settlement either in accordance with the provisions of the first schedule to this act or, if in their opinion suitable means for settlement already exist in pursuance of any agreement between employers and persons employed, for settlement in accordance with those means.

(3) Where a matter is referred under the last foregoing subsection for settlement otherwise than in accordance with the provisions of the first schedule to this act, and the settlement is in the opinion of the Board of Trade unduly delayed, the Board may annul the reference and substitute therefor a reference in accordance with the provisions of the said schedule.

(4) The award on any such settlement shall be binding both on employers and employed and may be retrospective; and if any employer, or person employed, thereafter acts in contravention of, or fails to comply with, the award, he shall be guilty of an offense under this act.

PROHIBITION OF LOCKOUTS AND STRIKES IN CERTAIN CASES.

2.—(1) An employer shall not declare, cause, or take part in a lockout, and a person employed shall not take part in a strike, in connection with any difference to which this part of this act applies, unless the difference has been reported to the Board of Trade, and 21 days have elapsed since the date of the report, and the difference has not during that time been referred by the Board of Trade for settlement in accordance with this act.

(2) If any person acts in contravention of this section, he shall be guilty of an offense under this act.

DIFFERENCES TO WHICH PART I APPLIES.

3. The differences to which this part of this act applies are differences as to rates of wages, hours of work, or otherwise as to terms or conditions of or affecting employment on the manufacture or repair of arms, ammunition, ships, vehicles, aircraft, or any other articles required for use in war, or of the metals, machines, or tools required for that manufacture or repair (in this

act referred to as munitions work); and also any differences as to rates of wages, hours of work, or otherwise as to terms or conditions of or affecting employment on any other work of any description, if this part of this act is applied to such a difference by His Majesty by proclamation on the ground that in the opinion of His Majesty the existence or continuance of the difference is directly or indirectly prejudicial to the manufacture, transport, or supply of munitions of war.

This part of this act may be so applied to such a difference at any time, whether a lockout or strike is in existence in connection with the difference to which it is applied or not:

Provided, That if in the case of any industry the Minister of Munitions is satisfied that effective means exist to secure the settlement without stoppage of any difference arising on work other than on munitions work, no proclamation shall be made under this section with respect to any such difference.

When this part of this act is applied to any difference concerning work other than munitions work the conditions of labor and the remuneration thereof prevailing before the difference arose shall be continued until said difference is settled in accordance with the provisions of this part of this act.

PART II.

CONTROLLED ESTABLISHMENTS.

4. If the Minister of Munitions considers it expedient for the purpose of the successful prosecution of the war that any establishment in which munitions work is carried on should be subject to the special provisions as to limitation of employers' profits and control of persons employed and other matters contained in this section, he may make an order declaring that establishment to be a controlled establishment, and on such order being made the following provisions shall apply thereto:

- (1) Any excess of the net profits of the controlled establishment over the amount divisible under this act, as ascertained in accordance with the provisions of this act, shall be paid into the exchequer.
- (2) Any proposal for any change in the rate of wages, salary, or other emoluments of any class of persons employed in the establishment, or of any persons engaged in the management or the direction of the establishment (other than a change for giving effect to any Government conditions as to fair wages or to any agreement between the owner of the establishment and the workmen which was made before the 23d day of June, 1915), shall be submitted to the Minister of Munitions, who may withhold his consent within 14 days of the date of the submission:

Provided, That if the Minister of Munitions so directs, or if the minister's consent is withheld and the persons proposing the change so require, the matter shall be referred for settlement in accordance with the provisions of the first schedule to this act, and the consent of the arbitration tribunal, if given, shall in that case have the same effect as the consent of the Minister of Munitions.

If the owner of the establishment or any contractor or subcontractor employing labor therein makes any such change, or attempts to make any such change, without submitting the proposal for the change to the Minister of Munitions or when the consent of the minister has been withheld, he shall be guilty of an offense under this act.

- (3) Any rule, practice, or custom not having the force of law which tends to restrict production or employment shall be suspended in the estab-

lishment, and if any person induces or attempts to induce any other person (whether any particular person or generally) to comply, or continue to comply, with such a rule, practice, or custom, that person shall be guilty of an offense under this act.

If any question arises whether any rule, practice, or custom is a rule, practice, or custom which tends to restrict production or employment, that question shall be referred to the Board of Trade, and the Board of Trade shall either determine the question themselves or, if they think it expedient or either party requires it, refer the question for settlement in accordance with the provisions contained in the first schedule to this act. The decision of the Board of Trade or arbitration tribunal, as the case may be, shall be conclusive for all purposes.

- (4) The owner of the establishment shall be deemed to have entered into an undertaking to carry out the provisions set out in the second schedule to this act, and any owner or contractor or subcontractor who breaks or attempts to break such an undertaking shall be guilty of an offense under this act.
- (5) The employer and every person employed in the establishment shall comply with any regulations made applicable to that establishment by the Minister of Munitions with respect to the general ordering of the work in the establishment with a view to attaining and maintaining a proper standard of efficiency and with respect to the due observance of the rules of the establishment.
If the employer or any person so employed acts in contravention of or fails to comply with any such regulation, that employer or person shall be guilty of an offense under this act.
- (6) The owners of an establishment shall have power, notwithstanding anything in any act, order, or deed under which they are governed, to do all things necessary for compliance with any provisions of this section, and any owner of an establishment shall comply with any reasonable requirements of the Minister of Munitions as to information or otherwise made for the purposes of this section, and, if he fails to do so, shall be guilty of an offense under this act.

Where in any establishment munitions work is carried on in some part of the establishment but not in other parts, the Minister of Munitions may, if he considers that it is practicable to do so, treat any part of the establishment in which munitions work is not carried on as a separate establishment, and the provisions of this act shall take effect accordingly.

SUPPLEMENTARY PROVISIONS AS TO THE LIMITATION OF THE PROFITS OF A CONTROLLED ESTABLISHMENT.

5.—(1) The net profits of a controlled establishment shall be ascertained in accordance with the provisions of this section and rules made thereunder, and the amount of profits divisible under this act shall be taken to be an amount exceeding by one-fifth the standard amount of profits.

(2) The standard amount of profits for any period shall be taken to be the average of the amount of the net profits for the two financial years of the establishment completed next before the outbreak of the war, or a proportionate part thereof.

(3) If in any case it appears or is represented to the Minister of Munitions that the net profits or losses of all or any other establishments belonging to the same owner should be brought into account, or that the average under this sec-

tion affords or may afford an unfair standard of comparison or affords no standard of comparison, the minister may, if he thinks just, allow those net profits or losses to be brought into account, or substitute for the average such an amount as the standard amount of profits as may be agreed upon with the owner of the establishment.

The Minister of Munitions may, if he thinks fit, and shall, if the owner of the establishment so requires, refer the matter to be determined by a referee or board of referees appointed or designated by him for the purpose, and the decision of the referee or board shall be conclusive on the matter for all purposes.

(4) The Minister of Munitions may make rules for carrying the provisions of this section into effect, and these rules shall provide for due consideration being given in carrying out the provisions of this section as respects any establishment to any special circumstances such as increase of output, provision of new machinery or plant, alteration of capital or other matters which require special consideration in relation to the particular establishment.

VOLUNTARY UNDERTAKING TO WORK FOR MINISTER OF MUNITIONS.

6.—(1) If any workman in accordance with arrangements made by the Minister of Munitions with or on behalf of trade unions enters into an undertaking with the Minister of Munitions that he will work at any controlled establishment to which he may be assigned by the minister, and be subject to the penalty imposed by this act if he acts in contravention of or fails to comply with the undertaking, that workman shall if he acts in contravention of or fails to comply with his undertaking be guilty of an offense under this act.

(2) If any employer dissuades or attempts to dissuade a workman in his employment from entering into an undertaking under this section, or retains or offers to retain in his employment any workman who has entered into such an undertaking after he has received notice from the Minister of Munitions that the workman is to work at some other establishment, that employer shall be guilty of an offense under this act.

PROHIBITION OF THE EMPLOYMENT OF PERSONS WHO HAVE LEFT WORK IN MUNITION FACTORIES.

7.—(1) A person shall not give employment to a workman, who has within the last previous six weeks, or such other period as may be provided by order of the Minister of Munitions as respects any class of establishment, been employed on or in connection with munitions work in any establishment of a class to which the provisions of this section are applied by order of the Minister of Munitions, unless he holds a certificate from the employer by whom he was last so employed that he left work with the consent of his employer or a certificate from the munitions tribunal that the consent has been unreasonably withheld.

(2) If any workman or his trade-union representative complains to a munitions tribunal in accordance with rules made with respect to those tribunals that the consent of an employer has been unreasonably withheld that tribunal may, after examining into the case, if they think fit, grant a certificate which shall, for the purposes of this section, have the same effect as a certificate from the employer.

(3) If any person gives employment in contravention of the provisions of this section, he shall be guilty of an offense under this act.

RULES AS TO BADGES.

8.—(1) The Minister of Munitions may make rules authorizing the wearing of badges or other distinctive marks by persons engaged on munitions work or other

work for war purposes, and as to the issue and return of any such badges or marks, and may by those rules prohibit the use, wearing or issue of any such badges or of any badges or marks indicating or suggesting that any person is engaged on munitions work or work for war purposes except as authorized by those rules.

(2) If any person acts in contravention of or fails to comply with any such rules he shall be guilty of an offense under this act.

APPLICATION OF PART II TO DOCKS USED BY ADMIRALTY.

9. This part of this act shall apply to any docks used by the Admiralty for any purposes connected with the war as it applies to establishments in which munitions work is carried on, with the substitution in relation to any such docks or persons employed in any such docks of the Admiralty for the Minister of Munitions.

PART III.

* * * * *

POWER TO REQUIRE INFORMATION FROM EMPLOYERS.

11.—(1) The owner of any establishment in which persons are employed shall, if so required by the Minister of Munitions, give to the minister such information, in such form and in such manner, as the minister may require as to—

- (a) the numbers and classes of persons employed or likely to be employed in the establishment from time to time;
- (b) the numbers and classes of machines at any such establishment;
- (c) the nature of the work on which any such persons are employed or any such machines are engaged from time to time;
- (d) any other matters with respect to which the minister may desire information for the purpose of his powers and duties;

and the minister may arrange with any other Government department for the collection of any such information.

(2) If the owner of any establishment fails to comply with this section he shall be guilty of an offense under this act.

PUNISHMENT FOR FALSE STATEMENTS, ETC.

12. If any employer, or the owner of any establishment or any workman, for the purpose of evading any provision of this act, makes any false statement or representation, or gives any false certificate, or furnishes any false information, he shall be guilty of an offense under this act.

PAYMENT OF MEMBERS OF ARBITRATION AND MUNITIONS TRIBUNALS, ETC.

13. There shall be paid out of moneys provided by Parliament to any person being a member of an arbitration tribunal, munitions tribunal, or board of referees under this act, or being a referee under this act, and to any other officers required in connection with any such tribunal or board, such remuneration and traveling or other expenses (including compensation for loss of time) as the Minister of Munitions or Board of Trade, as the case may be, with the sanction of the Treasury, may determine.

PENALTIES.

14.—(1) Any person guilty of an offense under this act—

- (a) shall, if the offense is a contravention of or failure to comply with an award, be liable to a fine not exceeding £5 for each day or part of a day during which the contravention or failure to comply continues, and, if the person guilty of the offense is an employer, for each man in respect of whom the contravention or failure takes place; and
- (b) shall, if the offense is a contravention of the provisions of this act with respect to the prevention of lockouts, be liable to a fine not exceeding £5, in respect of each man locked out, for each day or part of a day during which the contravention continues; and
- (c) shall, if the offense is a contravention of the provisions of this act with respect to the prohibition of strikes, be liable to a fine not exceeding £5 for each day or part of a day during which the contravention continues; and
- (d) shall, if the offense is a contravention of or failure to comply with any regulations in a controlled establishment or any undertaking given by a workman under Part II of this act, be liable in respect of each offense to a fine not exceeding £3; and
- (e) shall, if the offense is a contravention of or failure to comply with any other provisions of this act, be liable in respect of each offense to a fine not exceeding £50.

(2) A fine for any offense under this act shall be recoverable only before the munitions tribunal established for the purpose under this act.

MUNITIONS TRIBUNALS.

15.—(1) The munitions tribunal shall be a person, appointed for the purpose by the Minister of Munitions, sitting with two or some other even number of assessors, one half being chosen by the Minister of Munitions from a panel constituted by the Minister of Munitions of persons representing employers and the other half being so chosen from a panel constituted by the Minister of Munitions of persons representing workmen; and the Minister of Munitions may constitute two classes of munitions tribunals, the first class having jurisdiction to deal with all offenses and matters under this act, the second class having jurisdiction, so far as offenses are concerned, to deal only with any contravention of, or failure to comply with, any regulation made applicable to a controlled establishment or any undertaking given by a workman under Part II of this act.

The Admiralty shall be substituted for the Minister of Munitions under this provision as the authority to appoint and choose members of a munitions tribunal to deal with offenses by persons employed in any docks declared to be controlled establishments by the Admiralty.

(2) The Minister of Munitions or the Admiralty shall constitute munitions tribunals as and when occasion requires.

(3) Rules may be made for regulating the munitions tribunals or either class of munitions tribunals so far as relates to offenses under this act by a secretary of state, and so far as relates to any other matters which are referred to them under this act by the Minister of Munitions, and rules made by the secretary of state may apply, with the necessary modifications, any of the provisions of the summary jurisdiction acts or any provisions applicable to a court of summary jurisdiction, which it appears expedient to apply, and any provisions so applied shall apply to munitions tribunals accordingly.

* * * * *

(4) A person employed or workman shall not be imprisoned in respect of the nonpayment of a fine imposed by a munitions tribunal for an offense within the jurisdiction of a tribunal of the second class, but that tribunal may, without prejudice to any other available means of recovery, make an order requiring such deductions to be made on account of the fine from the wages of the person employed or workman as the tribunal think fit, and requiring the person by whom the wages are paid to account for any sums deducted in accordance with the order.

* * * * *

RULES TO BE LAID BEFORE PARLIAMENT.

17. Any rule made under this act shall be laid before each house of Parliament forthwith, and, if an address is presented to His Majesty by either house of Parliament within the next subsequent 21 days on which that house has sat next after any such rule is laid before it praying that the rule may be annulled, His Majesty in council may annul the rule, and it shall thenceforth be void, but without prejudice to the validity of anything previously done thereunder.

* * * * *

INTERPRETATION.

19. In this act, unless the context otherwise requires—

- (a) The expression "lockout" means the closing of a place of employment, or the suspension of work, or the refusal by an employer to continue to employ any number of persons employed by him in consequence of a dispute, done with a view to compelling those persons, or to aid another employer in compelling persons employed by him, to accept terms or conditions of or affecting employment.
- (b) The expression "strike" means the cessation of work by a body of persons employed acting in combination, or a concerted refusal or a refusal under a common understanding of any number of persons employed to continue to work for an employer in consequence of a dispute, done as a means of compelling their employer or any person or body of persons employed, or to aid other workmen in compelling their employer or any person or body of persons employed, to accept or not to accept terms or conditions of or affecting employment.

SHORT TITLE AND DURATION.

20.—(1) This act may be cited as the Munitions of War Act, 1915.

(2) This act shall have effect only so long as the office of Minister of Munitions and the Ministry of Munitions exist:

Provided, That Part I of this act shall continue to apply for a period of 12 months after the conclusion of the present war to any difference arising in relation to the performance by the owner of any establishment of his undertaking to carry out the provisions set out in the second schedule to this act, notwithstanding that the office of Minister of Munitions and the Ministry of Munitions have ceased to exist.

SCHEDULE I.

1. Any difference, matter, or question to be referred for settlement in accordance with the provisions of this schedule shall be referred to one of the three following arbitration tribunals:

- (a) The committee appointed by the first lord of the Treasury known as the committee on production; or

- (b) A single arbitrator to be agreed upon by the parties or in default of agreement appointed by the Board of Trade; or
- (c) A court of arbitration consisting of an equal number of persons representing employers and persons representing workmen with a chairman appointed by the Board of Trade.

2. The tribunal to which the reference is made shall be determined by agreement between the parties to the difference, or in default of such agreement by the Board of Trade.

3. The Arbitration Act, 1889, shall not apply to any reference under the provisions of this schedule.

SCHEDULE II.

1. Any departure during the war from the practice ruling in the workshops, shipyards, and other industries prior to the war shall only be for the period of the war.

2. No change in practice made during the war shall be allowed to prejudice the position of the workmen in the owners' employment, or of their trade unions in regard to the resumption and maintenance after the war of any rules or customs existing prior to the war.

3. In any readjustment of staff which may have to be effected after the war priority of employment will be given to workmen in the owners' employment at the beginning of the war who have been serving with the colors or who were in the owners' employment when the establishment became a controlled establishment.

4. Where the custom of a shop is changed during the war by the introduction of semiskilled men to perform work hitherto performed by a class of workmen of higher skill, the time and piece rates paid shall be the usual rates of the district for that class of work.

5. The relaxation of existing demarcation restrictions or admission of semi-skilled or female labor shall not affect adversely the rates customarily paid for the job. In cases where men who ordinarily do the work are adversely affected thereby, the necessary readjustments shall be made so that they can maintain their previous earnings.

6. A record of the nature of the departure from the conditions prevailing when the establishment became a controlled establishment shall be kept, and shall be open for inspection by the authorized representative of the Government.

7. Due notice shall be given to the workmen concerned wherever practicable of any changes of working conditions which it is desired to introduce as the result of the establishment becoming a controlled establishment, and opportunity for local consultation with workmen or their representatives shall be given if desired.

8. All differences with workmen engaged on Government work arising out of changes so introduced or with regard to wages or conditions of employment arising out of the war shall be settled in accordance with this act without stoppage of work.

9. Nothing in this schedule (except as provided by the fourth paragraph thereof) shall prejudice the position of employers or persons employed after the war.

MUNITIONS OF WAR (AMENDMENT) ACT, 1916. [JAN. 27, 1916.]

POWER TO DECLARE GOVERNMENT FACTORIES, ETC., CONTROLLED ESTABLISHMENTS.

1. The Minister of Munitions may by order declare any establishment or establishments belonging to or under the control of His Majesty or any Government Department in which munitions work is carried on to be a controlled establishment or controlled establishments, as the case may be, and thereupon the provisions of the Munitions of War Act, 1915¹ (hereinafter referred to as "the principal act"), and this act relating to controlled establishments shall apply to such an establishment or establishments subject to such modifications and exceptions necessary to adapt those provisions to such an establishment or establishments as may be specified in such order.

AMENDMENT OF SECTION 1 OF PRINCIPAL ACT.

2. Subsection (2) of section 1 of the principal act shall have effect as if after the words "in any case in which they think fit may" there were inserted the words "and in the case where the difference is a difference between an employer and persons employed which appears to the Board of Trade a bona fide difference and which the Board have failed to settle by such steps as aforesaid, shall within 21 days from the date of the report."

AMENDMENT OF SECTION 6 OF PRINCIPAL ACT.

3. (1) Where a workman has entered into an undertaking with the Minister of Munitions under section 6 of the principal act and was at the time of entering into that undertaking in the employment of any employer, then if that employer within the period of six weeks from the date of the undertaking dismisses that workman from his employment he shall be guilty of an offense under the principal act and shall be liable to a fine not exceeding £5 unless he proves that there was reasonable cause for dismissing the workman.

(2) It is hereby declared that where the fulfillment by any workman of any contract is interfered with by the necessity on his part of complying with an undertaking entered into by him under section 6 of the principal act, that necessity is a good defense to any action or proceedings taken against that workman in respect of the nonfulfillment of the contract so far as it is due to the interference and he shall be entitled to enter into such an undertaking notwithstanding the existence of such a contract.

(3) Section 6 of the principal act shall apply to a workman who had before the passing of the principal act entered into an undertaking of the nature mentioned in that section in like manner as if the undertaking had been entered into in pursuance of that section.

OFFENSES BY EMPLOYERS IN CONNECTION WITH MUNITIONS WORKERS ASSIGNED TO THEM.

4. Where a person who has been temporarily released from naval or military service for the purpose of employment on or in connection with munitions work, or a workman who has entered into an undertaking with the Minister of Munitions under section 6 of the principal act, or to whom that section is applied by this act, has been assigned to any employer, and that employer has entered into an undertaking with the Minister of Munitions as to the class or description of work on or in connection with which the person or workman

¹ 5 and 6 George 5, c. 54.

so assigned to him is to be employed, then, if the employer acts in contravention of or fails to comply with any of the provisions of the undertaking, he shall be guilty of an offense under the principal act and liable to a fine not exceeding £5.

AMENDMENT OF SECTION 7 OF PRINCIPAL ACT.

5. (1) Section 7 of the principal act shall have effect as if for subsections (1) and (2) of that section the following two subsections were substituted:

“(1) A person shall not give employment to a workman who has within the last previous six weeks, or such other period as may be provided by order of the Minister of Munitions as respects any class of establishment, been employed on or in connection with munitions work in any establishment of a class to which the provisions of this section are applied by order of the Minister of Munitions, unless he holds a certificate from the employer by whom he was last so employed or from a munitions tribunal that he is free to accept other employment.

“(2) If any workman or his trade-union representative complains to a munitions tribunal, in accordance with rules made with respect to those tribunals, that an employer has unreasonably refused or neglected to issue such a certificate as aforesaid, that tribunal may, after examining into the case, if it thinks fit, itself issue such a certificate or order the issue of such a certificate by the employer.”

(2) Where a workman employed on or in connection with munitions work in any establishment of a class to which the provisions of section 7 of the principal act are for the time being applied by an order made thereunder is dismissed or discharged by his employer the employer shall forthwith give him such a certificate as aforesaid, and if he fails to do so, a munitions tribunal may, in addition to issuing or ordering the issue to him of such a certificate, order the payment to him by the employer of such sum, not exceeding £5, as the tribunal may think fit, unless the tribunal is of opinion that the workman was guilty of misconduct for the purpose of obtaining dismissal or discharge.

This subsection shall apply to a workman who applies for a certificate on the ground that he has for a period of more than two days been given no opportunity of earning wages, or who leaves his employment on account of conduct on the part of the employer, or any agent of the employer, which would justify the immediate termination by the workman of his contract of service in like manner as if he had been dismissed or discharged by his employer.

(3) Where a contract of service with a workman employed on or in connection with munitions work in any establishment of a class to which the provisions of section 7 of the principal act are for the time being applied by an order made thereunder is terminated by dismissal, and less than one week's notice, or wages in lieu of notice, has or have been given, the employer shall, subject to the provisions of this subsection, within 24 hours of giving notice of dismissal to the workman, report the matter in such manner as may be prescribed by rules made by the Minister of Munitions, and such rules shall provide for the determination by a munitions tribunal (in case of difference) of the amount, if any, and not in any case exceeding £5, which is to be paid by the employer to the workman in lieu of notice, and for the payment of the sum so determined to the workman, unless the tribunal is of opinion that, owing to the discontinuance or temporary nature of the employment or misconduct of the workman, the employer had reasonable cause for dismissing the workman without a week's notice: *Provided*, That nothing in this subsection shall apply to workmen engaged in ship repairing or to any class of workmen

exempted in the prescribed manner on the ground that the circumstances of their employment were such that the provisions of this subsection ought not to apply to them.

(4) The provisions of section 7 of the principal act which prohibit the giving of employment to workmen in the circumstances mentioned in that section shall not apply so as to prevent the giving of employment to a workman in a controlled establishment to which he has been assigned by the Minister of Munitions in pursuance of section 6 of the principal act.

(5) In determining whether the grant of a certificate has been unreasonably refused for the purposes of section 7 of the principal act as amended by this section, a munitions tribunal shall take into consideration the question whether the workman has left or desires to leave his work for the purpose of undertaking any class of work in which his skill or other personal qualifications could be employed with greater advantage to the national interests, and whether the employer has failed to observe the conditions laid down in the fair-wages clauses required by resolution of the House of Commons to be inserted in Government contracts, and whether the workman has left or desires to leave his work because he has recently completed a term of apprenticeship or period of learning his trade or occupation and desires to obtain a full standard rate of wages applicable to fully qualified workmen in his trade or occupation.

(6) The Minister of Munitions may make rules for carrying section 7 of the principal act as amended by this section into effect, and in particular may by such rules provide—

- (a) for the issue, form, custody, duration, delivery up, and replacement in case of loss or destruction, of certificates;
- (b) for the issue of certificates to persons not engaged on or in connection with munitions work;
- (c) for prohibiting the insertion in a certificate issued by an employer of any matter other than the prescribed particulars;

and may provide for any breach of such rules being punishable as an offense under the principal act with a fine not exceeding five pounds [\$24.33].

(7) This section shall not come into operation until such date as may be fixed by the rules made thereunder.

RATES OF WAGES OF WOMEN EMPLOYED ON MUNITIONS WORK.

6. (1) Where female workers are employed on or in connection with munitions work in any establishment of a class to which the provisions of section 7 of the principal act as amended by this act are for the time being applied by an order made thereunder, the Minister of Munitions shall have power by order to give directions as to the rate of wages, or (subject, so far as the matter is one which is dealt with by the Factory and Workshops Acts, 1901 to 1911, to the concurrence of the Secretary of State) as to hours of labor, or conditions of employment of the female workers so employed.

(2) Any directions given by the Minister of Munitions under this section shall be binding on the owner of the establishment and any contractor or subcontractor employing labor therein and the female workers to whom the directions relate, and any contravention thereof or noncompliance therewith shall be punishable, in like manner as if the order in which the direction is contained was an award made in settlement of a difference under Part I of the principal act.

(3) No direction given under this section shall be deemed to relieve the occupier of any factory or workshop from the obligation to comply with the provisions of the Factory and Workshops Act, 1901 to 1911, or of any orders or regulations made thereunder, or to affect the liability of any person to be pro-

ceeded against for an offense under the Employment of Children Act, 1903,¹ so, however, that no person be twice punished for the same offense.

RATES OF WAGES OF SEMISKILLED AND UNSKILLED LABOR IN CONTROLLED ESTABLISHMENTS.

7. The Minister of Munitions shall have power by order to give directions as to the rate of wages, hours of labor, or conditions of employment of semi-skilled and unskilled men employed in any controlled establishment on munitions work being work of a class which, prior to the war, was customarily undertaken by skilled labor, or as to the time rates for the manufacture of complete shell and fuses and cartridge cases in any controlled establishment in which such manufacture was not customary prior to the war; and any direction so given shall be binding on the owner of the establishment, and any contractor or subcontractor employing labor therein, and the workers to whom the directions relate, and any contravention thereof or noncompliance therewith shall be punishable in like manner as if the order in which the direction is contained was an award made in settlement of a difference under Part I of the principal act.

ESTABLISHMENT OF SPECIAL ARBITRATION TRIBUNALS.

8. (1) The Minister of Munitions may constitute special arbitration tribunals to deal with differences reported under Part I of the principal act which relate to matters on which the Minister of Munitions has given or is empowered to give directions under the last two preceding sections, and the Board of Trade may refer any such difference for settlement to such tribunal in lieu of referring it for settlement in accordance with the first schedule to the principal act.

(2) The Minister of Munitions may also refer to a special arbitration tribunal so constituted, for advice, any question as to what directions are to be given by him under the said sections.

(3) The tribunal to which matters and questions relating to female workers are to be referred under this section shall include one or more women.

EXTENSION OF DEFINITION OF MUNITIONS WORK.

9. (1) The expression "munitions work" for the purposes of the principal act and this act means—

- (a) the manufacture or repair of arms, ammunition, ships, vessels, vehicles, and aircraft, and any other articles or parts of articles (whether of a similar nature to the aforesaid or not) intended or adapted for use in war, and of any other ships or vessels, or classes of ships or vessels, or parts of ships or vessels, which may be certified by the Board of Trade to be necessary for the successful prosecution of the war; and of any metals, machines, or tools required for any such manufacture or repair, and of the materials of any class specified in an order for the purpose by the Minister of Munitions, required for or for use in any such manufacture or repair as aforesaid; and
- (b) the construction, alteration, or repair of works of construction and buildings for naval or military purposes, and of buildings in which munitions work is or is intended to be carried on, and the erection of machinery and plant therein, and the erection of houses for the accommodation of persons engaged or about to be engaged on munitions work; and
- (c) the construction, alteration, repair, or maintenance of docks and harbors, and work in estuaries in cases where such construction,

¹ 3 Edward 7, c. 45.

alteration, repair, maintenance, or work is certified by the Admiralty to be necessary for the successful prosecution of the war; and

- (d) the supply of light, heat, water, or power, or the supply of tramways facilities in cases where the Minister of Munitions certifies that such supply is of importance for the purpose of carrying on munitions work, and the erection of buildings, machinery, and plant required for such supply; and
- (e) the repair of fire engines and any other fire-brigade appliances in cases where the Minister of Munitions certifies that such repair is necessary in the national interest.

(2) In section 3 of the principal act there shall be added after the words "affecting employment on," in both places where those words occur, the words "or in connection with," and in the same section the words "the manufacture or repair of arms, ammunition, ships, vehicles, aircraft, or any other articles required for use in war, or of the metals, machines, or tools required for that manufacture or repair in this act referred to as" shall be repealed.

(3) This section shall not come into operation until the time fixed by rules made under section 5 of this act as the date for the commencement of that section.

AMENDMENT OF SECTION 9 OF PRINCIPAL ACT.

10. At the end of section 9 of the principal act the following proviso shall be inserted:

"*Provided*, That the power of making an order applying section 7 of this act to any dock shall rest with the Minister of Munitions and not with the Admiralty."

AMENDMENT OF SECTION 4 OF PRINCIPAL ACT.

11. Subsection (2) of section 4 of the principal act shall be read as if the words "or to any agreement existing before the establishment became a controlled establishment, between the owner of the establishment and an employee with regard to any periodical increase of remuneration" were inserted after the words "nineteen hundred and fifteen."

EXPLANATION OF TERM "WORKMAN."

12. For removing doubts it is hereby declared that the expressions "workman" and "workmen," wherever they occur in the principal act and this act, include not only persons whose usual occupation consists in manual labor but also foremen, clerks, typists, draftsmen, and other persons whose usual occupation consists wholly or mainly in work other than manual labor.

AMENDMENT OF SECTION 16 OF PRINCIPAL ACT.

13. Subsection (4) of section 15 of the principal act shall be read as if the words "of the second class" were struck out.

PUNISHMENT FOR FALSE STATEMENTS, ETC.

14. For section 12 of the principal act the following section shall be substituted:

"12. If any person makes any false statement or representation, or gives any false certificate, or furnishes any false information—

"(a) for the purpose of evading any provision of this act; or

"(b) in any proceedings before any munition tribunal, arbitration tribunal, referee, or board of referees under this act or the rules made thereunder; or

“(c) to the Minister of Munitions or any officer employed by him, for the purpose of obtaining or retaining employment, or of obtaining or retaining the services of any workman;

or if any person alters or tampers with a certificate given under section 7 of this act, or personates or falsely represents himself to be a person to whom such a certificate has been given, or allows any other person to have possession of any such certificate issued for his use alone, he shall be guilty of an offense and liable on conviction under the Summary Jurisdiction Acts to imprisonment with or without hard labor for a term not exceeding three months or to a fine not exceeding fifty pounds” [\$243.33].

RESTRICTIONS ON CHANGE FROM UNION TO NONUNION LABOR.

15. Where nonunion labor is introduced during the war into any class of work in a controlled establishment in which it was the practice prior to the war to employ union labor exclusively, the owner of the establishment shall be deemed to have undertaken that such introduction shall only be for the period of the war, and if he breaks or attempts to break such an undertaking he shall be guilty of an offense under the principal act and liable to a fine not exceeding fifty pounds [\$243.33]; but, subject as aforesaid, such introduction shall not be deemed to be a change of working conditions.

EXTENSION OF SECTION 11 OF PRINCIPAL ACT.

16. (1) In subsection (1) of section 11 of the principal act, which specified the matters in respect of which owners of establishments in which persons are employed are, if required by the Minister of Munitions, to give information, the following paragraph shall be inserted after paragraph (c):

(cc) The cost of production of the articles produced or dealt with in the establishment, and the cost of the materials used for such production, and the names and addresses of the persons by whom such materials were supplied or who are under contract to supply them.

(2) If any person, except as authorized by the Minister of Munitions, discloses or makes use of any information given under section 11 of the principal act, as amended by this or any subsequent enactment, he shall be guilty of a misdemeanor and on conviction be liable to imprisonment, with or without hard labor, for a term not exceeding two years, or to a fine, or to both imprisonment and a fine.

POWERS OF INSPECTORS.

17. (1) An inspector appointed by the Minister of Munitions for the purposes of the principal act shall have power to enter at all reasonable times the premises of any establishment (other than a private dwelling house not being a workshop) for the purpose of ascertaining whether it is desirable to put in force as respects any establishment or any person employed therein any of the powers of the Minister of Munitions, whether under the principal act or otherwise, or for the purpose of obtaining any information in connection with the supply of munitions and to make such examination and inquiry as may be necessary for any such purpose, and the owner of the establishment and every person engaged in the management or direction of the establishment shall furnish to any such inspector all such information, and shall produce for inspection all such registers, wages books, and other similar documents as the inspector may reasonably require.

(2) If any person willfully delays or obstructs an inspector in the exercise of any power under this section or fails to give such information or to produce

such documents as aforesaid, he shall be guilty of an offense under the principal act, and shall be liable to a fine not exceeding ten pounds [\$48.67].

(3) Every inspector shall be furnished with a certificate as to his appointment, and on applying for admission to any premises for the purposes of this section shall, if so required, produce such certificate.

PROVISIONS AS TO OFFENSES.

18. (1) All offenses which are by or under this act made offenses under the principal act, other than those for which the maximum fine exceeds five pounds (\$24.33), shall be deemed to be offenses with which munitions tribunals of the second class have jurisdiction to deal.

(2) Rules under section 15 of the principal act shall provide—

(a) that in proceedings before a munitions tribunal the chairman shall, before giving his decision, consult with the assessors, and in all cases where the assessors are agreed he shall, except as respects questions which appear to the chairman to be questions of law, give effect to their opinion in his decision;

(b) that where the person or persons by or on behalf of whom or against whom the complaint is made in any proceedings before a munitions tribunal is or are a female worker, or two or more female workers, the assessor or one of the assessors chosen from the panel of persons representing workmen shall be a woman.

(3) Decisions of munitions tribunals shall be subject to appeal to such judge of the High Court as may be appointed by the Lord Chancellor for the purpose on any ground which involves a question of law or a question of mixed law and fact, or on any other ground that may be prescribed in rules made by the Lord Chancellor, in such cases and subject to such conditions and in such manner as may be specified in such rules, and whether by means of the statement of a special case for the opinion of the judge or otherwise; and those rules may provide for such appeals in any classes of cases specified therein being heard and determined in a summary manner and for the fixing, remission, or reduction of any fees and scales of costs, and as to the manner in which effect is to be given to the decision of the judge, and the decision of the judge on any such appeal shall be final and binding on all munitions tribunals.

(4) In the case of a company being guilty of an offense under the principal act, every director, manager, secretary, or other officer of the company who is knowingly a party to the contravention or noncompliance constituting the offense shall also be guilty of the offense and liable to the like fine as the company.

(5) In subsection (3) of section 15 of the principal act, after the words "so far as relates to offenses," there shall be inserted "and the enforcement of orders."

MINOR AMENDMENTS OF PRINCIPAL ACT.

19. In subsection (3) of section 5 of the principal act, after the words "affords no standard of comparison," there shall be inserted the words "or that no such average exists," and after the words "if he thinks just, allow," there shall be inserted the words "or require"; and in paragraph 9 of the second schedule to the principal act, for the word "fourth," there shall be substituted the word "third."

ARRANGEMENTS WITH OTHER DEPARTMENTS.

20. The Minister of Munitions may make arrangements with any other Government department for the exercise and performance by that department of any of his powers and duties under the principal act or this act which appear

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to him to be such as could be more conveniently so exercised and performed, and in such case the department and the officers of the department shall have the same powers and duties for the purpose as are by the principal act and this act conferred on the Minister of Munitions and his officers.

ADMISSIBILITY IN EVIDENCE OF CERTIFICATES BY BOARD OF TRADE.

21. For the purposes of proceedings under section 2 of the principal act, a certificate of the Board of Trade, purporting to be signed by the president or a secretary or assistant secretary of the Board of Trade, or by a person authorized for the purpose by the president, that a difference to which Part I of the principal act applies has or has not been reported to the Board, and, in cases where such a difference has been reported, as to the date on which it was reported, shall be admissible as evidence of the facts therein stated.

COSTS IN VEXATIOUS PROCEEDINGS.

22. (1) Where a munitions tribunal dismisses any case under the principal act, or this act, and it appears to the tribunal that the proceedings were vexatious or frivolous, the tribunal shall, unless it sees good cause to the contrary, award costs to the person against whom the complaint is made, and the costs so awarded shall, unless good cause to the contrary appears, include such sum as compensation for the expenses, trouble, and loss of time incurred in or incidental to the attendance of the person against whom the complaint is made before the tribunal as to the tribunal may seem just and reasonable.

(2) Where a referee or board of referees to whom a matter has, under subsection (3) of section 5 of the principal act, been referred by the Minister of Munitions on the requirement of the owner of an establishment considers that the requirement was unreasonable, the referee or board of referees may order that any costs payable by the owner of the establishment shall be paid out of the amount of profits divisible under the principal act.

EXCLUSION OF ARBITRATION ACT, 1889 (52 AND 53 VICT., C. 49).

23. The Arbitration Act, 1889, shall not apply to any reference to any referee or board of referees under the principal act or this act or the rules made thereunder.

EFFECT OF REVOCATION OF ORDERS.

24. Where the Minister of Munitions makes an order revoking any order previously made by him under section 4 of the principal act, the order so revoked shall, if that order has not been in operation for more than three months and was made under a misapprehension and the revoking order so directs, be treated for all or any of the purposes thereof as if it had never had effect.

PROVISION AS TO RULES.

25. Rules and Regulations made under the principal act as amended by this act shall not be deemed to be statutory rules within the meaning of section 1 of the Rules Publication Act, 1893.¹

DURATION OF PRINCIPAL ACT.

26. In subsection (2) of section 20 of the principal act, which relates to the duration thereof, the words "Part I of" shall be repealed.

SHORT TITLE.

27. This act may be cited as the Munitions of War (Amendment) Act, 1916, and shall be construed as one with the principal act, and the principal act and the act may be cited together as the Munitions of War Acts, 1915 and 1916.

¹ 56 and 57 Vict., c. 66.

**THE MUNITIONS TRIBUNALS (PROVISIONAL) RULES, 1915,
DATED JULY 12, 1915, FOR CONSTITUTING AND REGULATING
MUNITIONS TRIBUNALS IN ENGLAND AND WALES, MADE IN PURSUANCE OF SECTION 15 OF THE
MUNITIONS OF WAR ACT, 1915.**

PROVISIONS APPLICABLE TO TRIBUNALS OF THE SECOND CLASS.

1. A munitions tribunal of the second class (hereinafter referred to as a local munitions tribunal) shall consist of a person (hereinafter referred to as the chairman) appointed for the purpose by the Minister of Munitions sitting with assessors drawn respectively from an employers' panel and from a workmen's panel constituted by the Minister of Munitions in accordance with these rules and duly summoned to serve on such local munitions tribunal.

2. A local munitions tribunal shall have jurisdiction to deal only with complaints that any person has acted in contravention of or failed to comply with regulations made applicable to the controlled establishment in which he is either an employer or is employed or an undertaking into which a workman has entered under section 6 (1) of the Munitions of War Act, 1915¹ (hereinafter referred to as the act), and complaints that an employer has unreasonably withheld his consent under section 7 of the act.

3. A local munitions tribunal shall be constituted in accordance with the regulations set out in the first schedule hereto, being regulations made under Part II, of the National Insurance Act, 1911,² with reference to courts of referees, adapted for the purposes of the act.

4. Any complaint with which a local munitions tribunal is competent to deal shall be made by any person aggrieved or by or on behalf of the Minister of Munitions in writing to the chairman of the local munitions tribunal appointed for the district in which the matter arose, or to some other person appointed by him for the purpose.

5. If no sitting of a local munitions tribunal shall previously have been fixed at which such complaint may conveniently and expeditiously be heard, the chairman shall cause assessors to be summoned to attend a special meeting of the tribunal in accordance so far as may be with the rota. Notice of the sitting shall be given wherever practicable not less than one week in advance.

6. Where the complaint relates to an offense under the act:

- (i) The chairman, or some other person appointed as aforesaid, shall (if satisfied that there is a *prima facie* case) issue a notice in the form set out in the second schedule hereto or such other form as a secretary of state may determine to the person or persons in respect of whom the complaint is made, to appear before the tribunal at such place and time as the chairman may appoint. A notice posted as a registered letter by or on behalf of the chairman to the last known place of abode of such person or persons shall be deemed to have been duly served.

¹ 5 and 6 George, c. 5, 54; see p. 125.

² 1 and 2 George c. 5, 55.

- (ii) The chairman or some other person appointed as aforesaid, shall send to the person who has made the complaint notice of the time and place of the hearing.
 - (iii) No person shall be fined for an offense under the act unless he has appeared before the local munitions tribunal or the tribunal is satisfied that he has had a reasonable opportunity of so appearing.
 - (iv) The tribunal shall for the purpose of adjudicating upon any such complaint have power to take evidence upon oath.
 - (v) So far as is consistent with the provisions of the act and any rules made thereunder, the provisions of the summary jurisdiction acts¹ and the criminal justice administration act, 1914,² with regard to requiring the attendance of any persons before a court of summary jurisdiction and with regard to the recovery of fines otherwise than by imprisonment, shall apply to proceedings under the act as though the local munitions tribunal were a court of summary jurisdiction, and as if the chairman were a justice of the peace or other magistrate having jurisdiction in the place where the court sits, a complaint were an information laid upon oath, a notice to appear were a summons duly issued and served, and an offense under this act were an offense punishable on summary conviction.
 - (vi) Where a fine has been imposed on a person employed or a workman by a local munitions tribunal, that tribunal may make an order requiring such deductions to be made on account of the fine from the wages of such person employed or workman as the tribunal think fit and requiring the person by whom the wages are paid to pay to the clerk to the tribunal or other person appointed for the purpose by the Minister of Munitions any sums so deducted.
7. Where the complaint relates to the withholding of consent by an employer under section 7 of the act:
- (i) The chairman or some other person appointed as aforesaid shall (if satisfied that there is a prima facie case) issue a notice in the form set out in the third schedule hereto, or such other form as the Minister of Munitions may determine, to the person or persons in respect of whom the complaint is made, to appear before the tribunal at such place and time as the chairman may appoint.
 - (ii) Notice of the time and place of sitting of the local munitions tribunal to which this complaint will be reported or referred shall be sent to the person by whom the complaint was made so that it would reach him in the ordinary course of post not less than 24 hours before the sitting of the tribunal, and such person shall be entitled to attend such sitting during the consideration of his case, provided that with the consent of such person the case may be considered by a local munitions tribunal notwithstanding that notice has not been given to him in accordance with this rule.
 - (iii) In any case in which it appears that the evidence of any person is necessary to the decision of the case, the chairman may direct that such person or persons be summoned to attend the tribunal, and expenses in respect of such attendance shall be allowed on a scale approved by the treasury.

¹ "The summary jurisdiction acts" means in relation to England and Wales, the Summary Jurisdiction Act, 1848 (11 and 12 Vict., c. 43), and the Summary Jurisdiction Act, 1879 (42 and 43 Vict., c. 49), and any act past or future amending those acts or either of them. See Interpretation Act, 1889 (52 and 53 Vict., c. 63), s. 13 (7) (10).

² 4 and 5 George, c. 5, 58.

8. No party to any proceeding before a local munitions tribunal shall be represented by counsel or solicitor.

PROVISIONS APPLICABLE TO TRIBUNALS OF THE FIRST CLASS.

9. A munitions tribunal of the first class (hereinafter referred to as a general munitions tribunal) shall consist of a person (hereinafter referred to as the chairman) appointed for the purpose by the Minister of Munitions sitting with assessors drawn respectively from an employers' panel and from a workmen's panel provided for the purpose by the Minister of Munitions and may be constituted generally or for any district specified by the Minister of Munitions.

10. A general munitions tribunal shall have jurisdiction to deal with all offenses under this act and any other matters therein specified, but shall not deal with any matter with which a local munitions tribunal is competent to deal unless such matter arises in connection with a matter with which a local munitions tribunal is not competent to deal or is for any reason referred to the general munitions tribunal by the Minister of Munitions.

11. Any complaint relating to any matter with which a local munitions tribunal is not competent to deal shall be made in writing by any person aggrieved or by or on behalf of the Minister of Munitions or by any person acting on the instructions, general or special, of the Minister of Munitions to the chairman of a general munitions tribunal appointed for the district in which the matter arose or to the Minister of Munitions who shall forthwith refer the case to a general munitions tribunal.

12. Where the complaint relates to an offense under the act the provisions of Rule 6 shall apply, subject to the following modifications:

(i) The words "General munitions tribunal" shall be substituted for the words "Local munitions tribunal" wherever they occur.

(ii) The chairman, or some other person appointed by him for the purpose, shall (if satisfied that there is a prima facie case) issue a notice in the form set out in the fourth schedule hereto or such other form as a secretary of state may determine to the person or persons in respect of whom the complaint is made, to appear before the tribunal at such place and time as the chairman may appoint.

(iii) Any person upon whom a fine of £20 [\$97.33] or more has been imposed by a general munitions tribunal may appeal to a court of quarter sessions in the same manner as if he were appealing from the conviction of a court of summary jurisdiction.

(iv) Subclause (v) shall be read as if the words "otherwise than by imprisonment" were struck out except as regards offenses within the jurisdiction of a local munitions tribunal.

13. Where the complaint relates to the withholding of consent by an employer under section 7 of the act the provisions of Rule 7 shall apply as though the words "General munitions tribunal" were substituted for the words "Local munitions tribunal."

PROVISIONS APPLICABLE TO BOTH CLASSES OF TRIBUNALS.

14. No case shall be heard, tried, or adjudged except in open court.

15. The chairman shall consult with his assessors before giving his decision.

16. The question of costs shall be in the absolute discretion of the chairman, who may order the same to be paid by any party or parties to the proceedings in such manner as he shall direct, and may either assess the amount thereof himself or may refer the same for assessment to any other person appointed by

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the Minister of Munitions for the purpose. An order for costs may be enforced by the tribunal in the same way as a fine.

17. The Minister of Munitions shall appoint for each tribunal a clerk, to whom all fines shall be paid; fines shall be paid by him into the Exchequer.

18. Every tribunal shall keep a register of complaints made to them and proceedings taken by them under the act, and shall furnish the Minister of Munitions with duplicates thereof when required by him to do so.

19. Subject as aforesaid, the procedure of a munitions tribunal shall be such as a Secretary of State or the Minister of Munitions may determine.

20. The Interpretation Act, 1889,¹ shall apply for the purpose of the interpretation of these rules as it applies to the interpretation of an act of Parliament.

21. These rules may be cited as the munitions (tribunals) rules, 1915, and shall come into force as from the 12th day of July, 1915.

Signed as far as relates to offenses by

JOHN SIMON,

One of H. M. Secretaries of State.

HOME OFFICE, Whitehall, S. W.

Signed as far as relates to other matters by

D. LLOYD GEORGE,

Minister of Munitions.

MINISTRY OF MUNITIONS,

6 Whitehall Gardens, S. W.

JULY 12, 1915.

SCHEDULE 1.

1. Unless the Minister of Munitions shall otherwise direct, the members of panels of persons representing employers and workmen constituted under section 90 of the National Insurance Act, 1911, for their respective districts, shall, if willing to serve, be the panels for the purposes of local munitions tribunals for the same districts.

2. The term of office of the chairman and of the members of the panels shall be such period as the Minister of Munitions may direct.

3. Casual vacancies on the panels, whether of employers or workmen, may be filled by the Minister of Munitions, and any person employed to fill a vacancy shall hold office until the expiration of the period during which the person in whose place he is appointed would have held office: *Provided*, That the Minister shall not be bound to fill any casual vacancy unless he thinks fit so to do, and a panel shall not be deemed to be improperly constituted by reason only that a casual vacancy on the panel has not been filled.

4. Each member of the panel shall, so far as practicable, be summoned to serve in turn upon the local munitions tribunal from a rota, prepared in advance. Such summons shall be by notice given not less than one week in advance wherever practicable: *Provided*, That where a meeting of a local munitions tribunal takes place immediately before or after a meeting of a court of referees for the same district the members of the employers' and workmen's panels summoned to serve as members of such court of referees may be summoned to serve also as assessors on such tribunal.

5. The chairman shall be appointed by the Minister of Munitions, and no person who is either an employer or a workman in any trade or group of trades

¹ 52 and 53 Vict., c. 63.

to which the provisions of Part II of the act apply shall be qualified for appointment as chairman.

6. In the event of any member of a panel being unavoidably prevented from attending a sitting of a local munitions tribunal at the time when he is summoned in accordance with the rota, any other member of the panel may be summoned in his place.

7. A supplementary local munitions tribunal may be constituted for any district at any time by the Minister of Munitions, and members of the panel for that district may be summoned to attend such tribunal by one clear day's notice, if practicable.

92103°—Bull. 221—17—10

COMPULSORY ARBITRATION IN MUNITIONS INDUSTRY IN FRANCE.

As a result of strikes in several French munition factories in the Paris district following upon demands for increased wages, the French Minister of Munitions, on January 17, 1917, issued a report and decree providing for the establishment of permanent boards of conciliation and arbitration composed of equal numbers of representatives of employers and of workers, for the immediate investigation and adjustment of collective disputes.

Immediately upon notice of a dispute the establishment is placed under military control, and any cessation of work is prohibited under severe penalties. The decree provides for an immediate hearing, and if conciliation fails a decision of the board as arbitrator within 24 hours after the hearing. In the case of the failure of the board to agree, a referee must be appointed without delay and a decision rendered within 24 hours after a hearing. In case of difficulty in agreeing upon appointment of a referee, the Minister of Munitions may himself designate a referee or may himself render a decision upon the matters in dispute. The decision of the arbitration board or of the referee becomes effective immediately upon its approval by the Minister of Munitions, and if any employer or the employees refuse to comply with the decision the establishment or the employees shall be immediately placed under military control.

The text of the decree follows:

TEXT OF DECREE OF MINISTER OF MUNITIONS OF JANUARY 17, 1917, FOR REGULATION OF DISPUTES IN MUNITIONS FACTORIES.

ARTICLE 1. Employers, workmen, and salaried persons in private establishments, factories, and enterprises engaged in the manufacture of armaments, munitions, and war materials, shall, in case of a dispute of a collective nature relating to conditions of labor, not be permitted to break the contract of labor, nor to stop or cease work before having submitted the questions in dispute to conciliation and arbitration, such as are provided for in the following articles.

ART. 2. There shall be established under the supervision of the Minister of Munitions, in such districts as shall be determined by him for this purpose, a permanent board of conciliation and arbitration composed of an equal number of representatives of employers and workers, but not less than two of each class. These representatives are to be exempt from military duty.

ART. 3. The collective differences shall be stated by a declaration made to the Controller of Labor, either by the employer or his representative or by a workman bearing a written authorization, free of stamp duty, signed by at least 20 other workmen.

ART. 4. The Controller of Labor shall notify the Board of Conciliation and Arbitration, provided for in article 2, and advise the Minister of Munitions, who shall designate a representative of his office to appear before the committee for the hearing.

The committee shall assemble at the local mayor's office without undue delay, hear the parties one or more times, and if terms of conciliation are not reached by them, it shall issue, within 24 hours after the last hearing its decision as arbitrator which shall be placed on record and signed by each member of the committee.

ART. 5. If a unanimous decision can not be rendered by the arbitrators, they shall designate one or more referees. If an agreement is not reached as to this appointment, the Minister of Munitions has the authority either to designate referees or to referee the dispute himself.

ART. 6. The referee or referees summoned without delay by the Controller of Labor, shall hear the arbitrators and the parties, and within 24 hours after the hearing shall render their decision in a written report.

The decision of the arbitration board provided for in articles 4 and 5 shall be in force as soon as it has been officially approved by the Minister of Munitions or by his order, and beca posted in the workrooms by the employer or, if he fails to do so, by the Controller of Labor, at the expense of the employer.

ART. 7. If the Minister himself acts as referee, his decision shall be published and becomes effective in the same manner.

ART. 8. If the employer refuses to conform to the decision of the arbitration board, the industrial establishment shall be placed under military control in accordance with articles 58 and 60 of the law of July 3, 1877, amended by the laws of March 5, 1890, July 17, 1898, April 17, 1901, March 27, 1906, and July 23, 1911.

ART. 9. If the decision of the arbitration board orders the payment to the workmen, in accordance with the decree of August 10, 1890, of sums, supplementary to the wages, or otherwise, and if the employer refuses to conform to such order, the administrative personnel of the industrial establishment shall be placed, in virtue of the disposition above mentioned, under military control for the purpose of effecting the necessary payments.

The sums necessary to make these payments shall be advanced by the Ministry of Munitions, to be subsequently retained from sums due to the employer by the State.

ART. 10. Should there be workmen refusing to comply with the arbitrator's decision, they shall be placed under military control in accordance with article 5, paragraph 8, or of articles 58 and 60 of the law of July 3, 1877, before cited.

ART. 11. Whenever the Controller of Labor is served with a notice of a collective dispute, he shall immediately give notice of it to the district military authority.

From the time of the notification of the Controller of Labor of the dispute until the posting of the decision of the arbitration board the above-named military authority shall place under military control (in conformity with articles 58 and 60 of the law of July 3, 1877, amended by the laws of March 5, 1890, July 17, 1898, April 17, 1901, March 27, 1906, and July 23, 1911) the entire directing administrative personnel and the working force of the establishment, so that order and continuity of production may be maintained.

ART. 12. The provisions of the arbitral decision, rendered for one or more establishments or for one or more classes of workers, may, by decision of the Minister of Munitions, be made applicable in the district affected, to all or a portion of the other establishments in this district or to other occupational groups which may be found in comparable conditions.

ART. 13. The provisions of this decree are not applicable to mobilized persons, for whom the conditions of work shall continue to be determined by the Controller of Labor, in conformity with the normal and current conditions in the specific occupations in the district.

(Continued from second page of cover.)

A list of bulletins issued since July 1, 1912, in the series "Industrial Accidents and Hygiene" is as follows:

- No. 1: Lead poisoning in potteries, tile works, and porcelain enameled sanitary ware factories. (Bul. 104.)
- No. 2: Hygiene of the painters' trade. (Bul. 120.)
- No. 3: Diseases to workers from dusts and fumes, and methods of protection. (Bul. 127.)
- No. 4: Lead poisoning in the smelting and refining of lead. (Bul. 141.)
- No. 5: Industrial accident statistics. (Bul. 157.)
- No. 6: Lead poisoning in the manufacture of storage batteries. (Bul. 163.)
- No. 7: Industrial poisons used in the rubber industry. (Bul. 179.)
- No. 8: Report of British departmental committee on the danger to the use of lead in the painting of buildings. (Bul. 186.)
- No. 9: Report of committee on statistics and compensation insurance work of the International Association of Industrial Accident Boards and Commissions. (Bul. 201.)
- No. 10: Anthrax as an occupational disease. (Bul. 205.)
- No. 11: Cause of death by occupation. (Bul. 207.) [In press.]
- No. 12: Hygiene of the printing trades. (Bul. 209.) [In press.]
- No. 13: Accidents and accident prevention in machine building. (Bul. 216.) [In press.]
- No. 14: Industrial poisons used or produced in the manufacture of explosives. (Bul. 218.) [In press.]

The following bulletins, published since July 1, 1912, but not included in the series "Industrial Accidents and Hygiene," also contain important material relating to the subject:

- Bul. 203: July, 1912, Cause of tuberculosis among exiles in Germany.
- Bul. 122, May, 1913, Employment of women in power handlooms in Manchester.
- Bul. 183, February, 1914, Administration of labor laws and factory inspection in certain European countries.
- Bul. 145, April, 1913, Conciliation, arbitration, and amputation in the dress and waist industry of New York City.

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